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Lee et al.

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(54) **IMAGE DISPLAY DEVICE AND METHOD OF CONTROLLING THE SAME**

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(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**

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H04N 5/66	(2006.01)
H04N 5/64	(2006.01)
H04N 21/442	(2011.01)
G06K 9/00	(2006.01)
G06F 3/01	(2006.01)

(52) **U.S. Cl.**

CPC ***H04N 5/66*** (2013.01); ***G06F 3/011*** (2013.01); ***G06K 9/00228*** (2013.01); ***H04N 5/64*** (2013.01); ***H04N 21/44218*** (2013.01); *G09G 2340/04* (2013.01); *G09G 2354/00* (2013.01); *G09G 2380/02* (2013.01)

(58) **Field of Classification Search**

CPC G06K 9/00228; G06K 2354/00; G06K 2380/02; G06K 2340/04; H04N 5/66; H04N 5/64; H04N 21/44218; G06F 3/011

USPC 348/77, 739

See application file for complete search history.

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(57) **ABSTRACT**

An image display device including a main body; a flexible display unit arranged on a front side of the main body; a drive unit arranged on a rear side of the flexible display unit and configured to bend at least one part of the flexible display unit; and a controller configured to search for a user location and control the drive unit to transform the at least one part of the flexible display unit based on the searched user location.

16 Claims, 21 Drawing Sheets

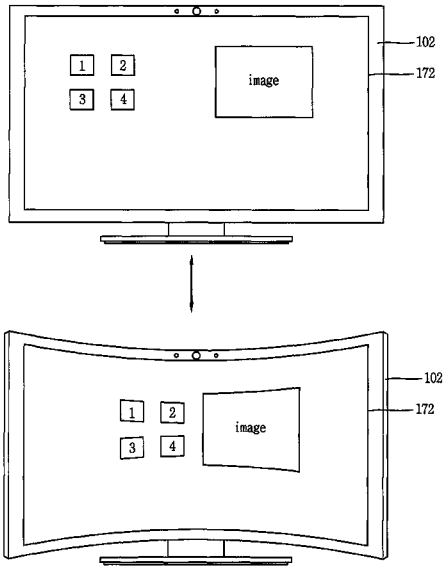

FIG. 1

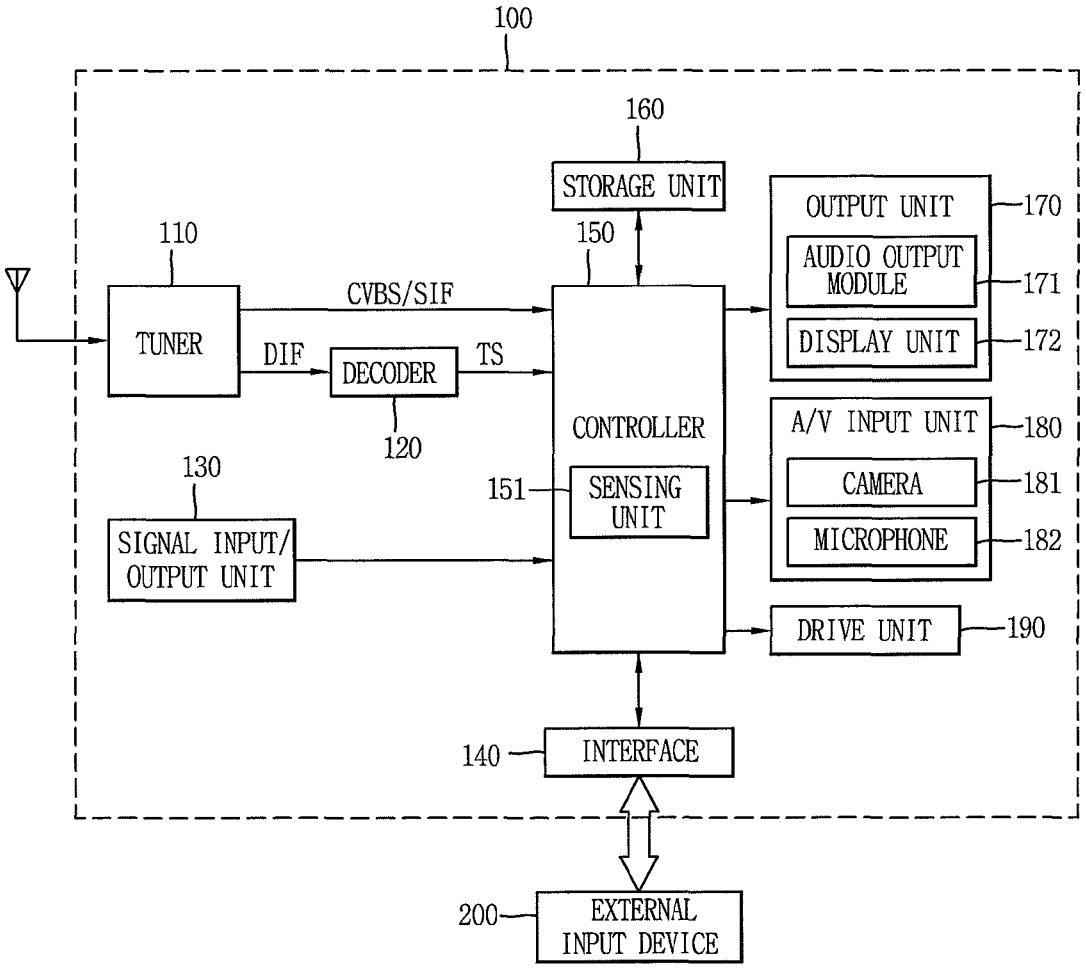
100
160
STORAGE UNIT
OUTPUT UNIT
170
AUDIO OUTPUT MODULE
171
DISPLAY UNIT
172
110
150
CVBS/SIF
TUNER
DIF
DECODER
TS
120
CONTROLLER
A/V INPUT UNIT
180
CAMERA
181
MICROPHONE
182
130
151
SENSING UNIT
SIGNAL INPUT/ OUTPUT UNIT
DRIVE UNIT
190
140
INTERFACE
200
EXTERNAL INPUT DEVICE

FIG. 2

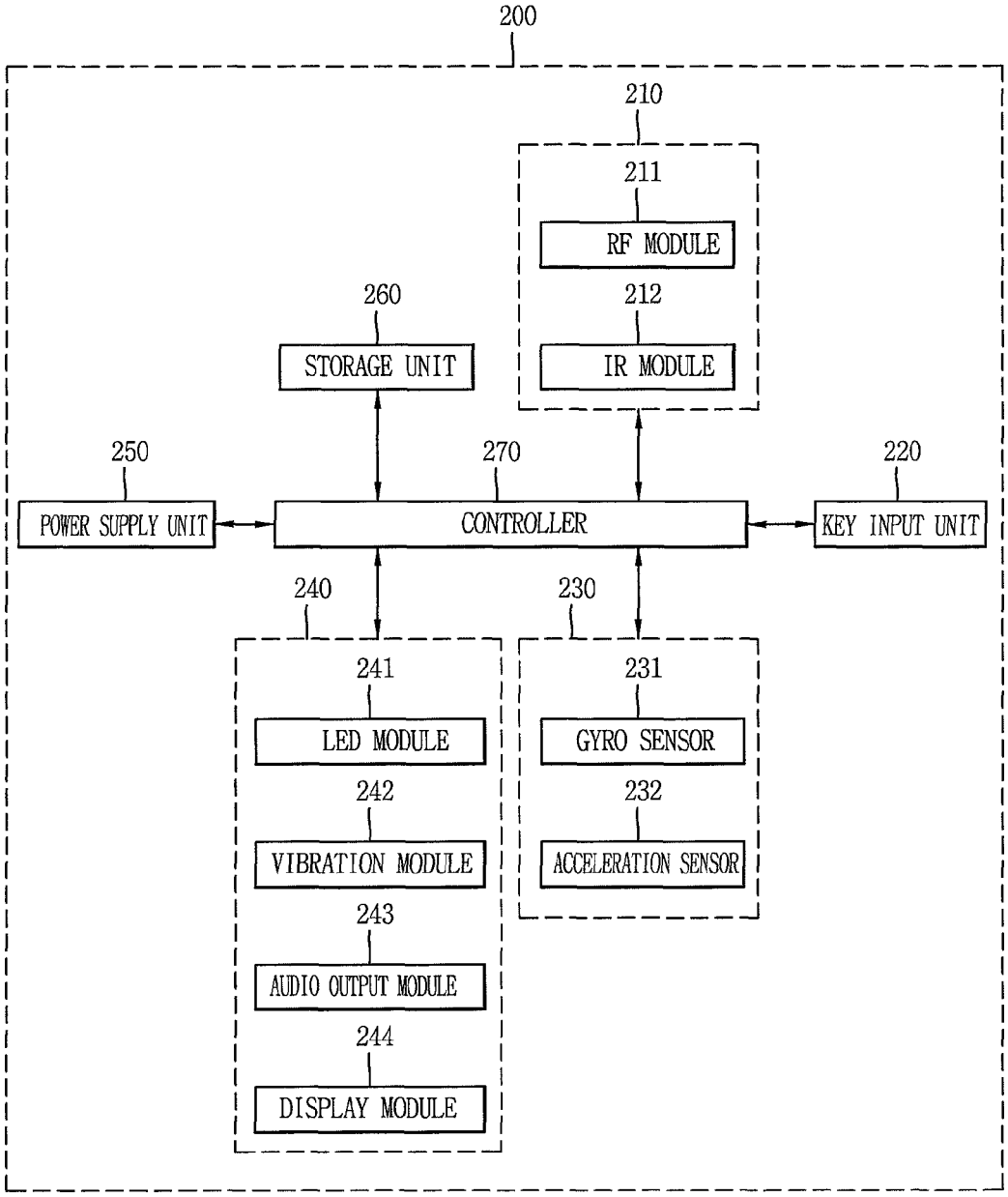
200
210
211
RF MODULE
212
IR MODULE
260
STORAGE UNIT
250
270
220
POWER SUPPLY UNIT
CONTROLLER
KEY INPUT UNIT
240
230
241
LED MODULE
242
VIBRATION MODULE
243
AUDIO OUTPUT MODULE
244
DISPLAY MODULE
231
GYRO SENSOR
232
ACCELERATION SENSOR

FIG. 3

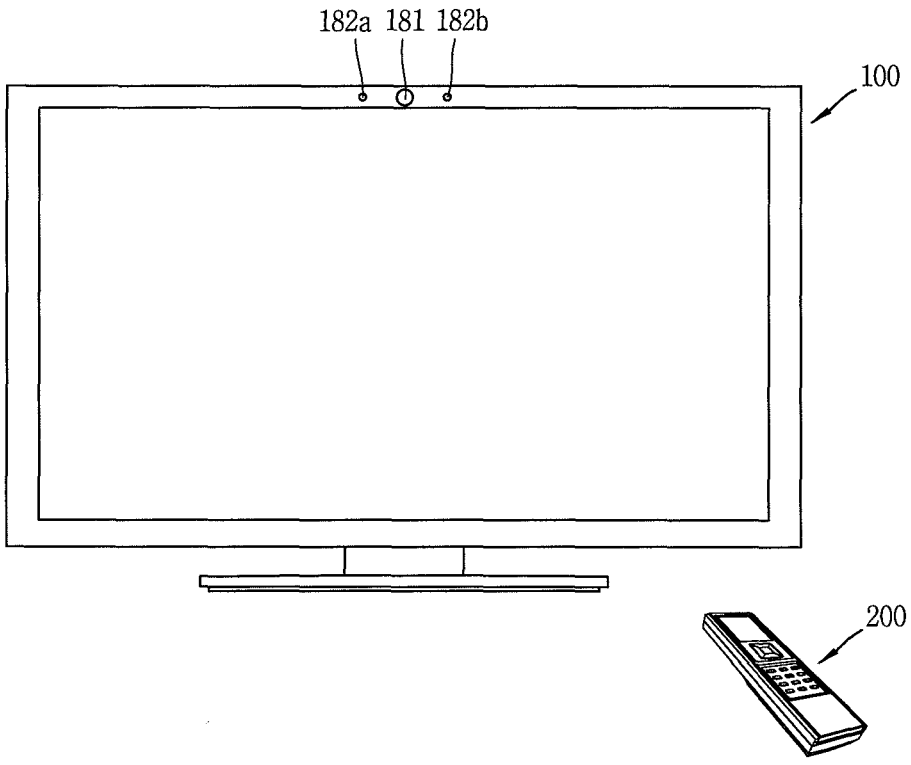

FIG. 4

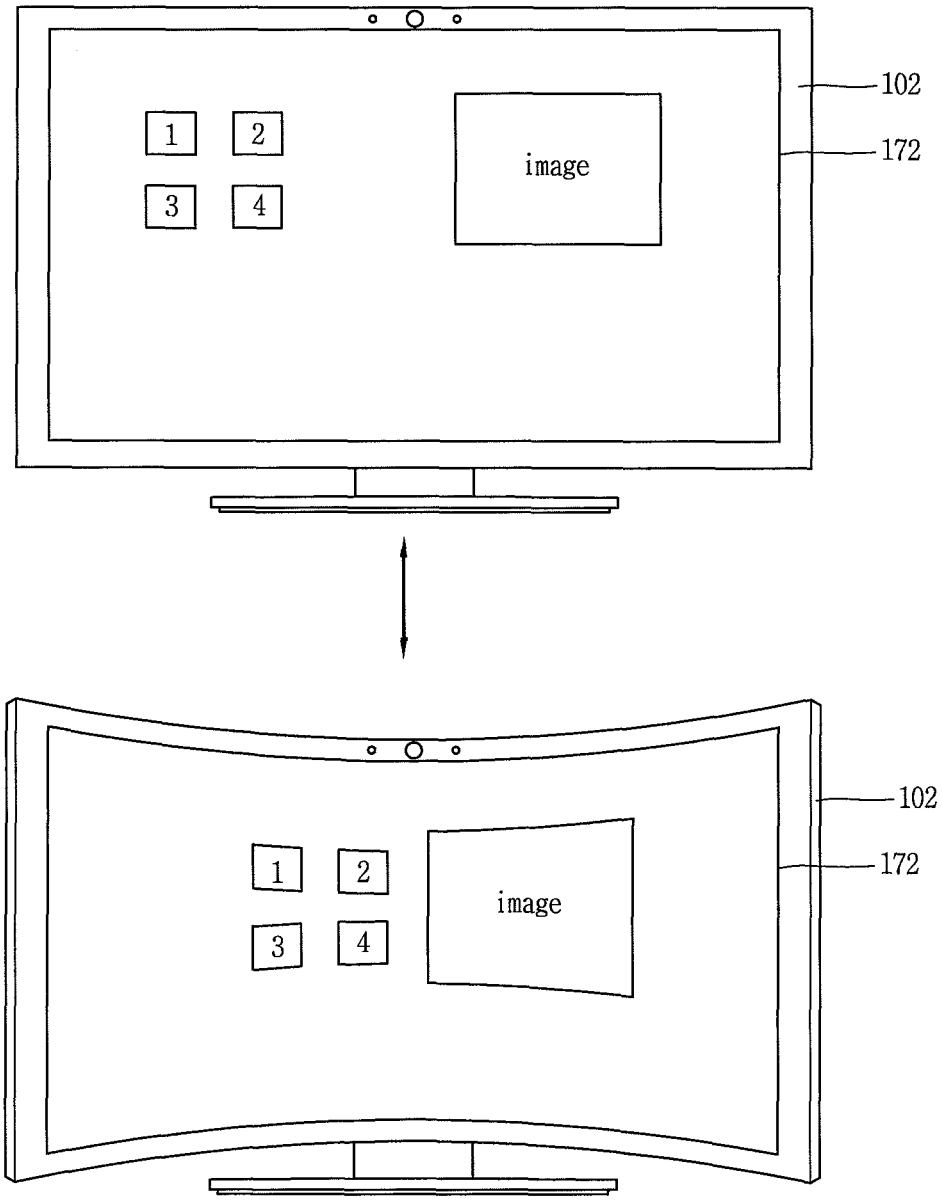

FIG. 5

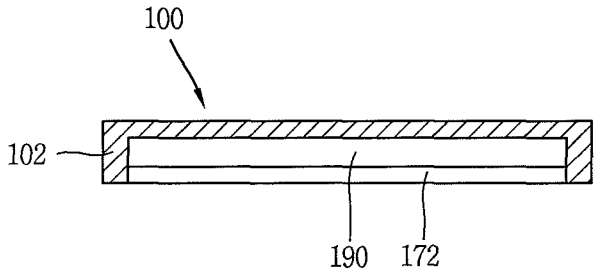
100
102
190
172

FIG. 6

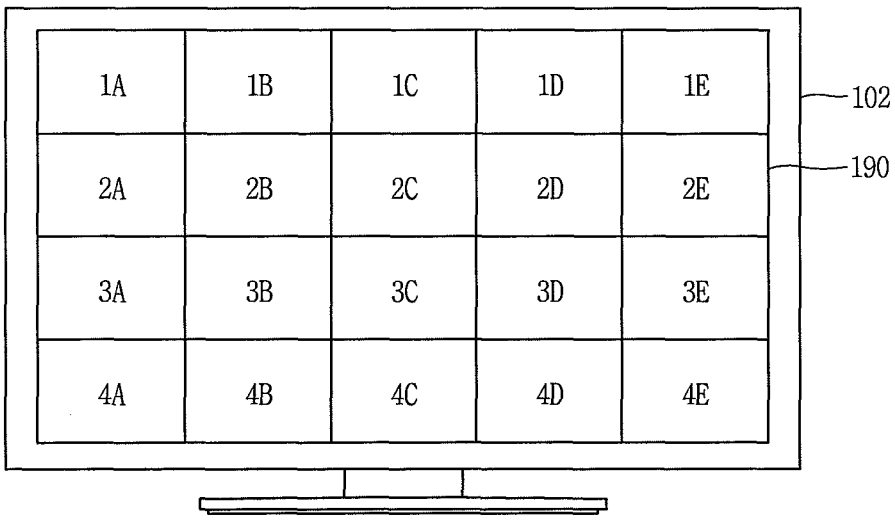
1A
1B
1C
1D
1E
2A
2B
2C
2D
2E
3A
3B
3C
3D
3E
4A
4B
4C
4D
4E
102
190

FIG. 7

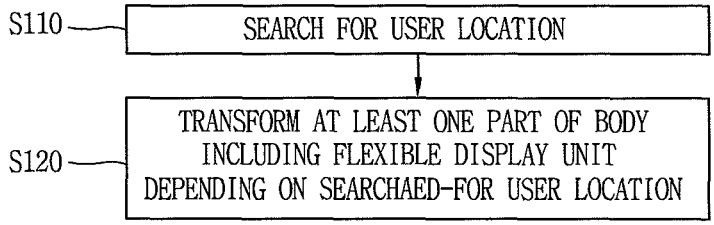
S110
SEARCH FOR USER LOCATION
S120
TRANSFORM AT LEAST ONE PART OF BODY INCLUDING FLEXIBLE DISPLAY UNIT DEPENDING ON SEARCHAED-FOR USER LOCATION

FIG. 8

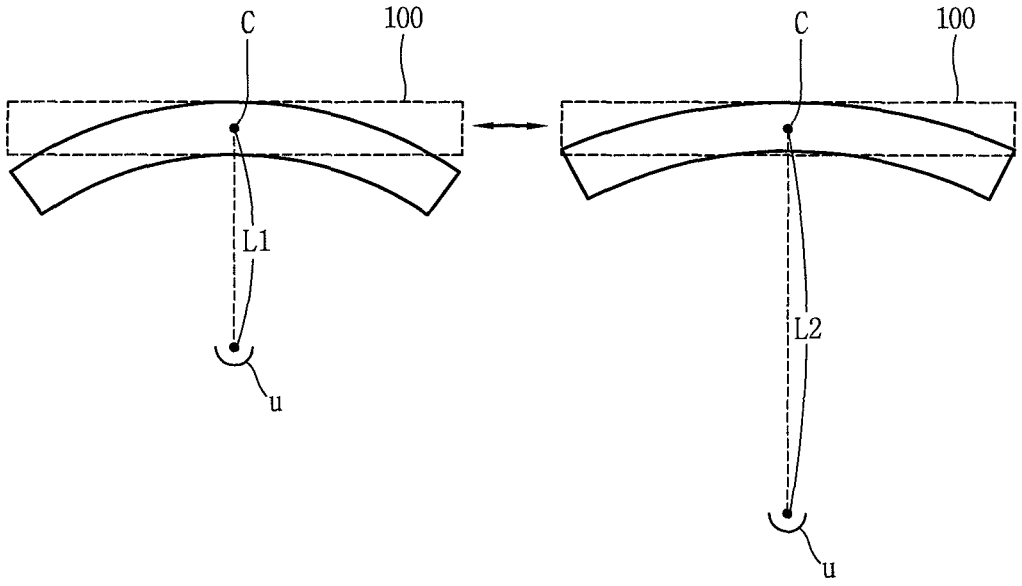
C
100
L1
u
C
100
L2
u

FIG. 9A

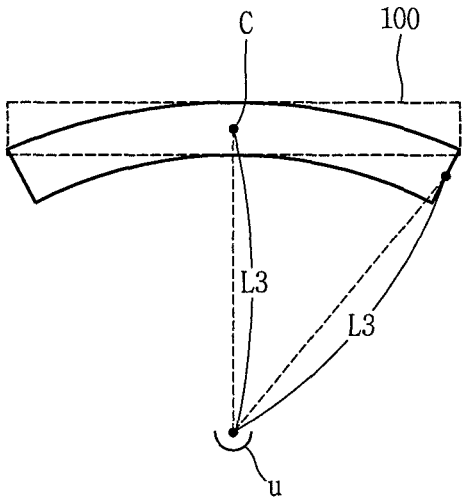

FIG. 9B

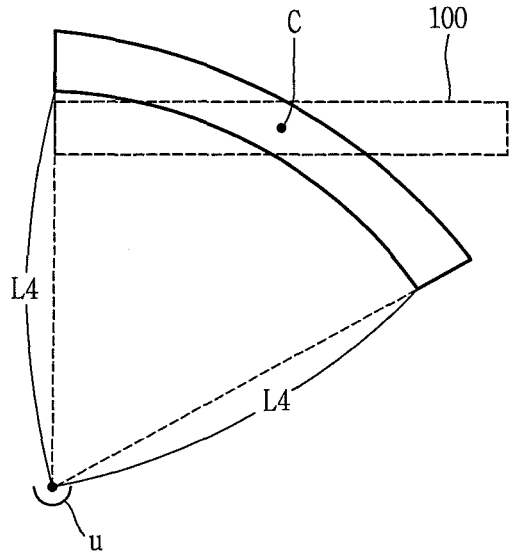

FIG. 9C

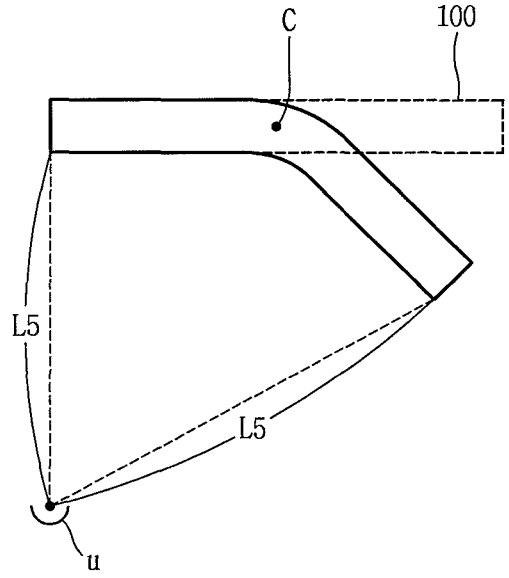

FIG. 10

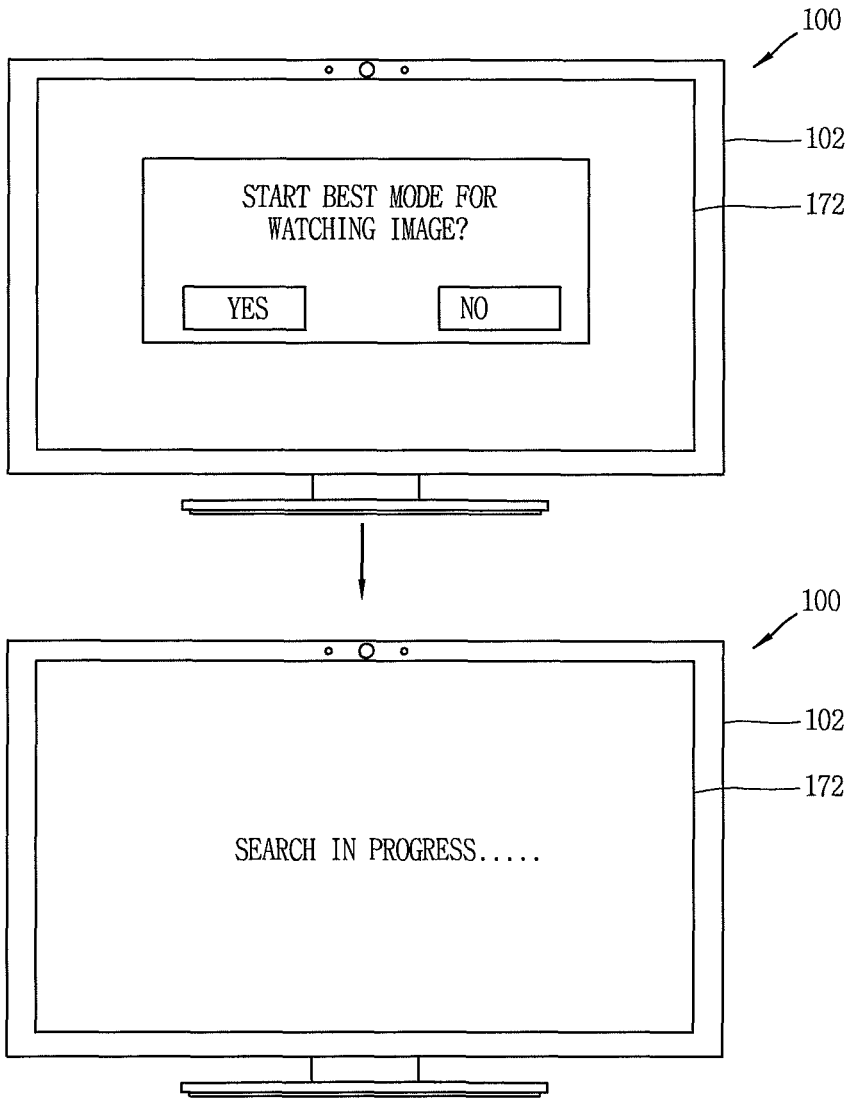
100
102
172
START BEST MODE FOR WATCHING IMAGE?
YES
NO
100
102
172
SEARCH IN PROGRESS.....

FIG. 11

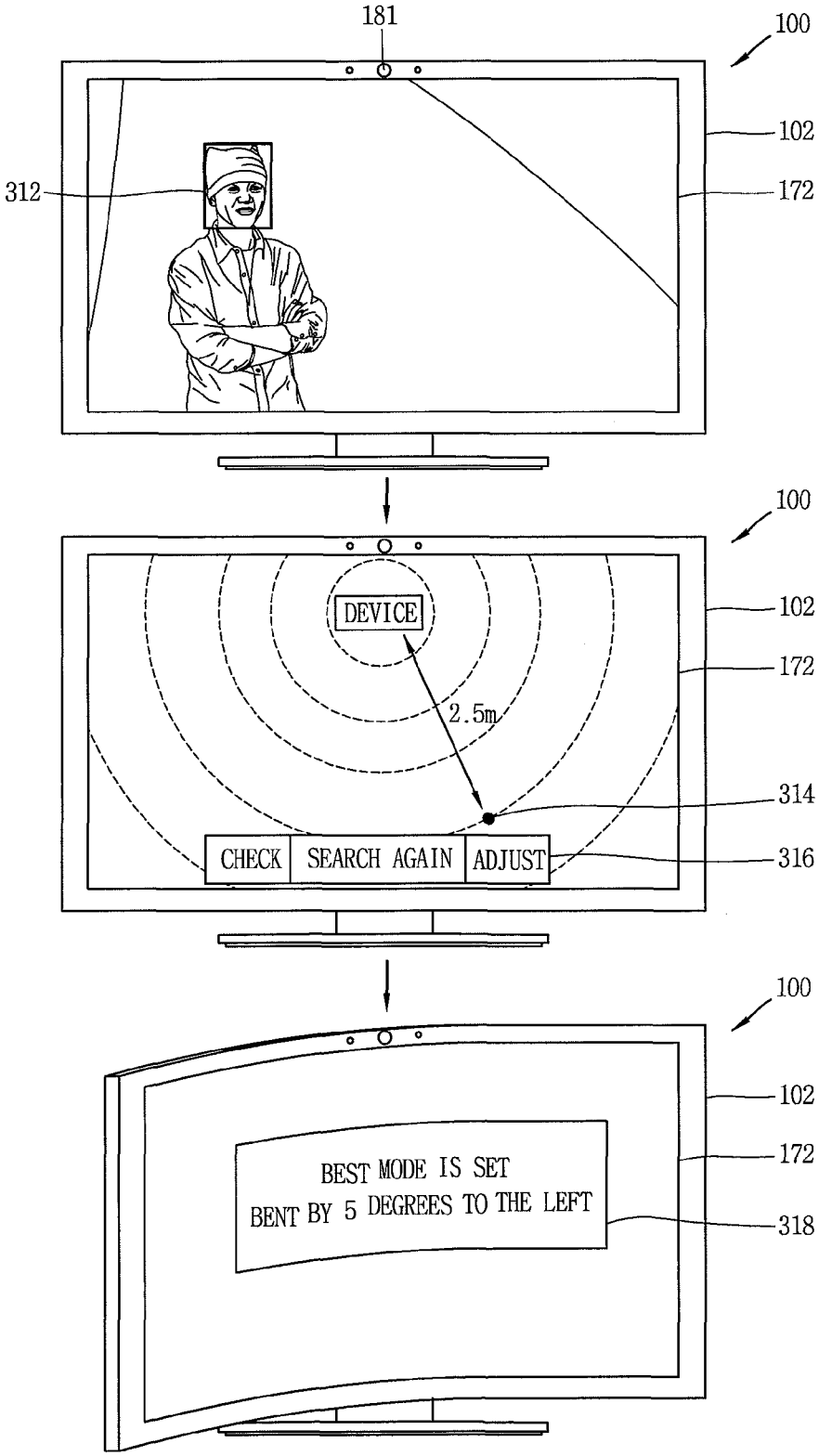
181
100
102
312
172
100
DEVICE
102
172
2.5m
314
CHECK
SEARCH AGAIN
ADJUST
316
100
102
172
BEST MODE IS SET
BENT BY 5 DEGREES TO THE LEFT
318

FIG. 12

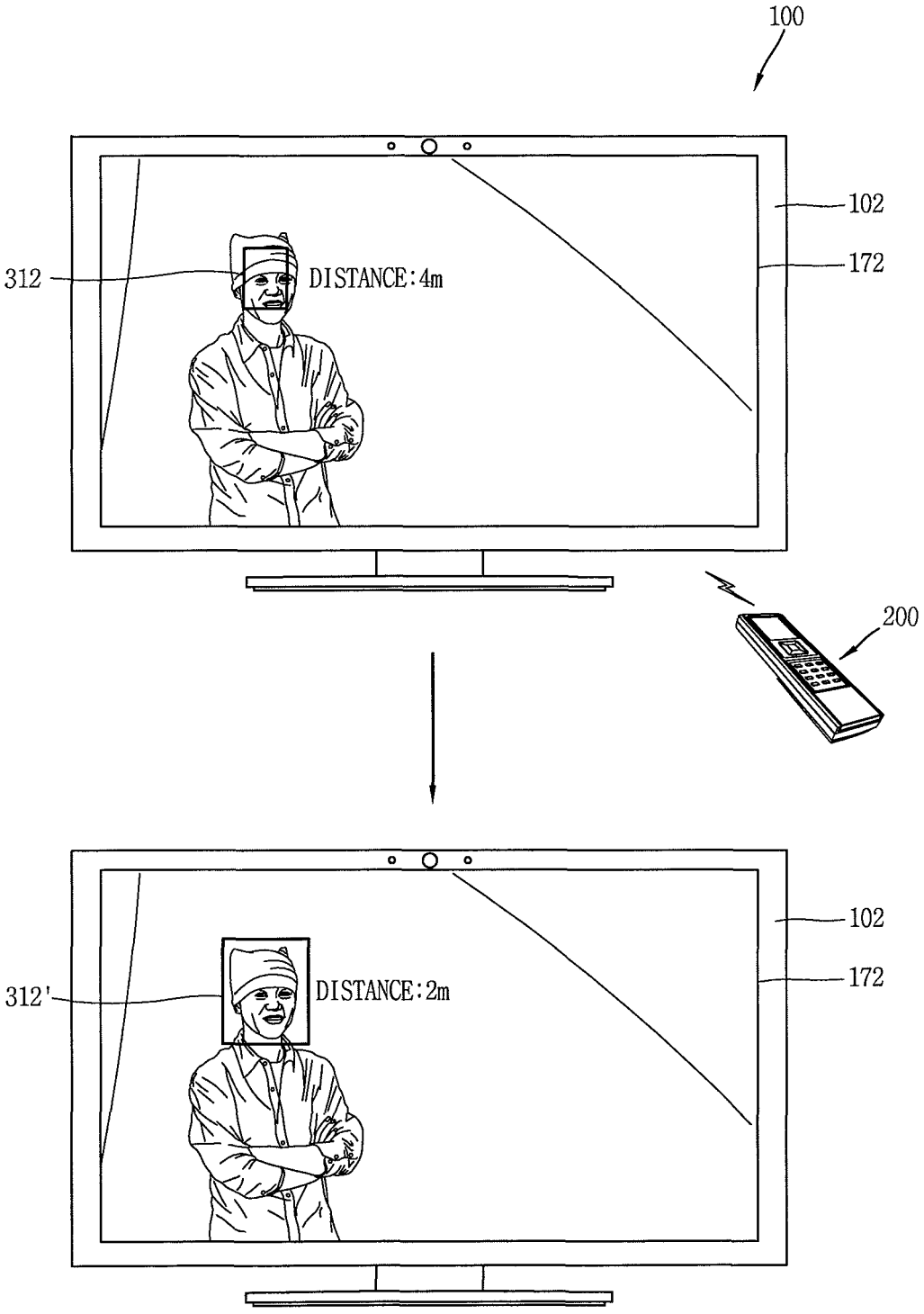

FIG. 13

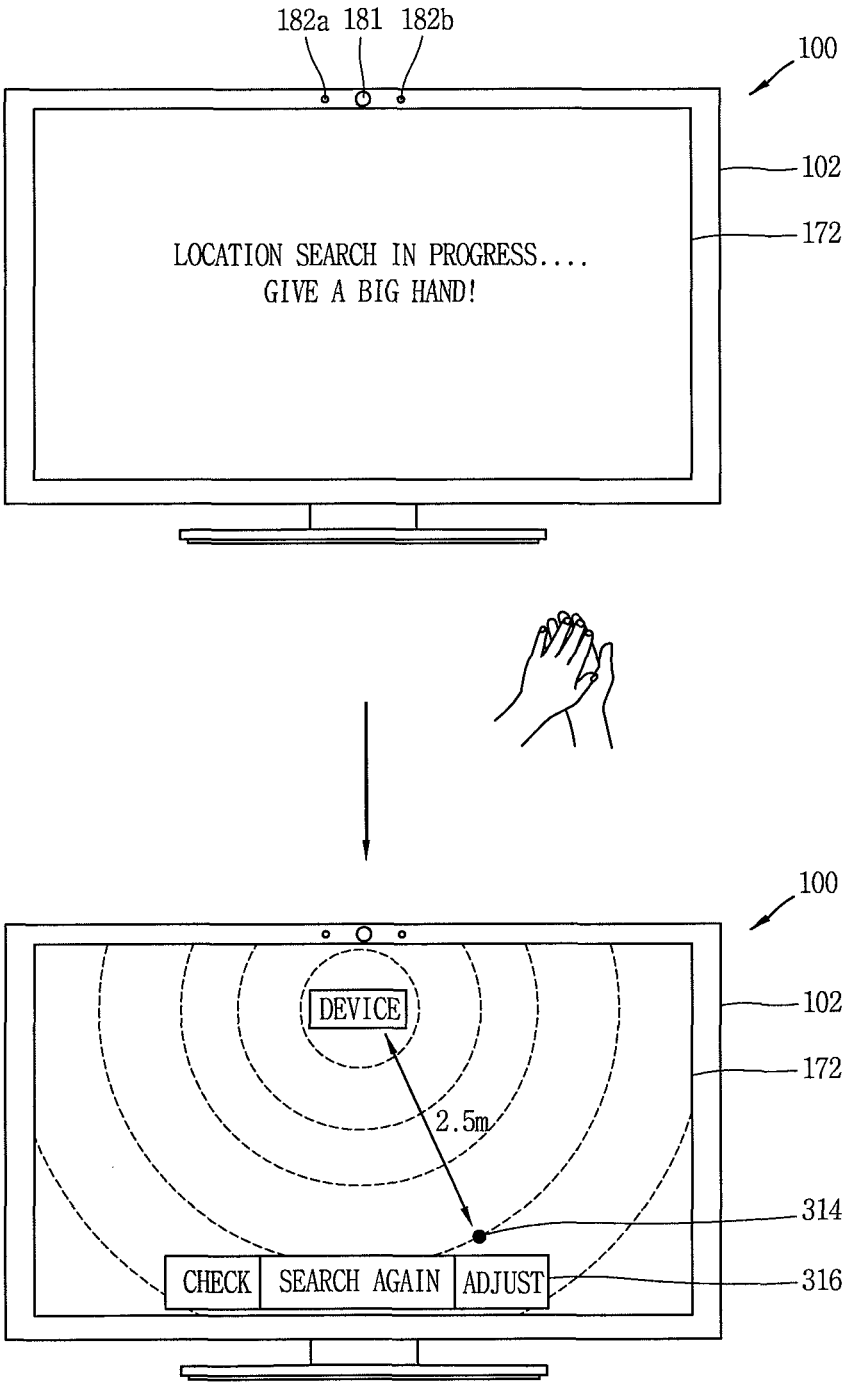
182a
181
182b
100
102
172
LOCATION SEARCH IN PROGRESS....
GIVE A BIG HAND!
100
102
172
DEVICE
2.5m
314
CHECK
SEARCH AGAIN
ADJUST
316

FIG. 14

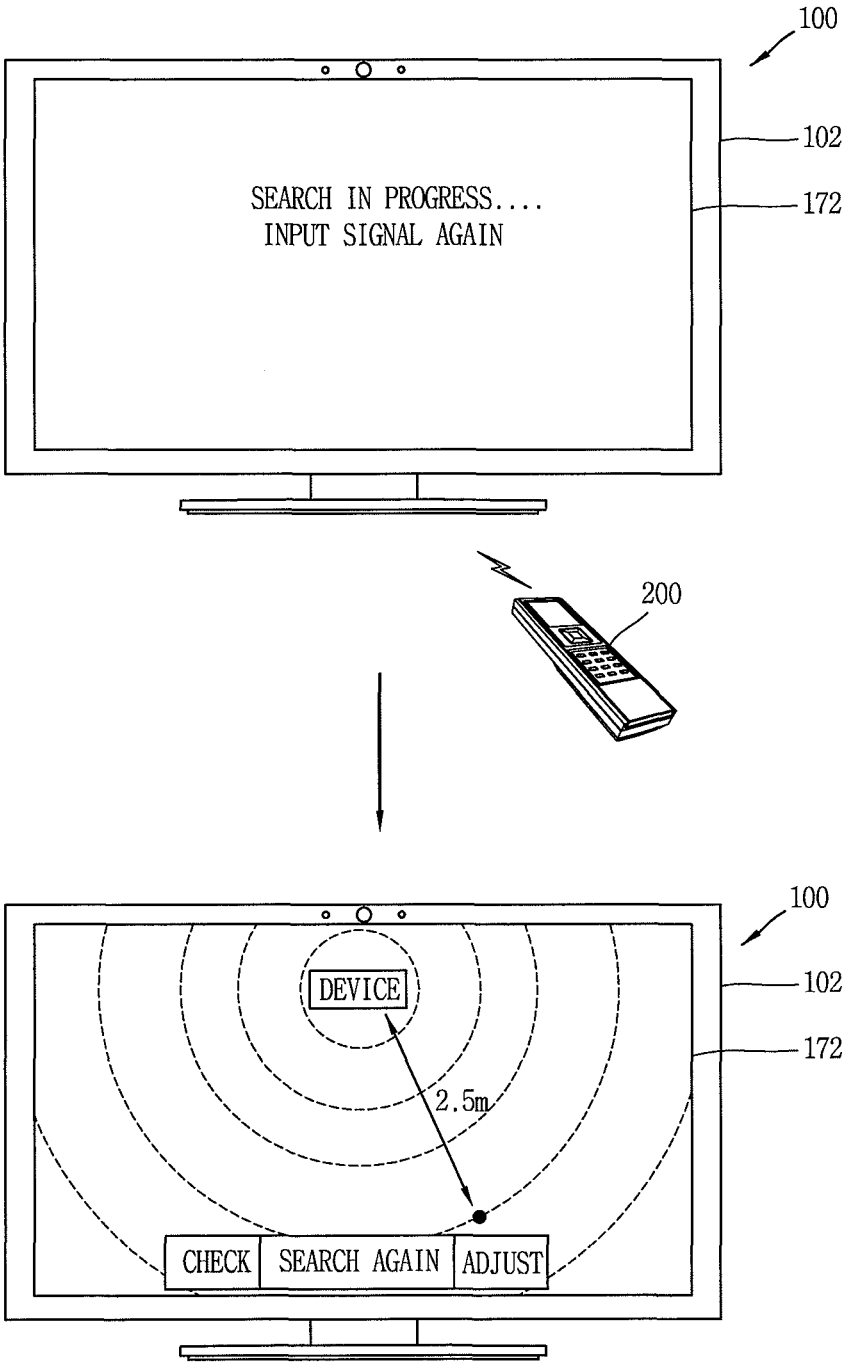
100
102
172
SEARCH IN PROGRESS....
INPUT SIGNAL AGAIN
200
100
102
172
DEVICE
2.5m
CHECK
SEARCH AGAIN
ADJUST

FIG. 15

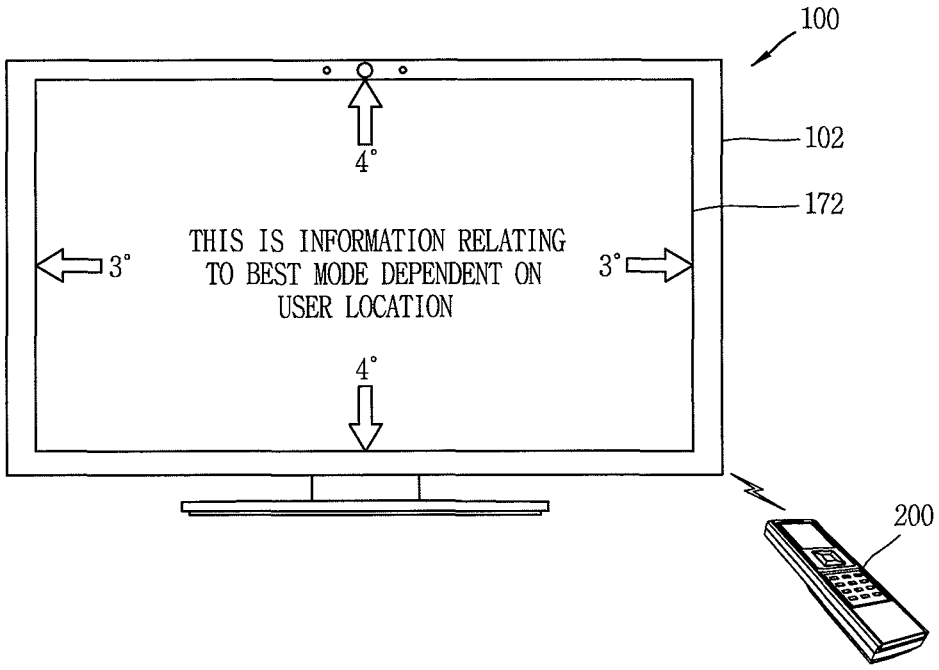
100
102
172
4°
3°
THIS IS INFORMATION RELATING TO BEST MODE DEPENDENT ON USER LOCATION
3°
4°
200

FIG. 16A

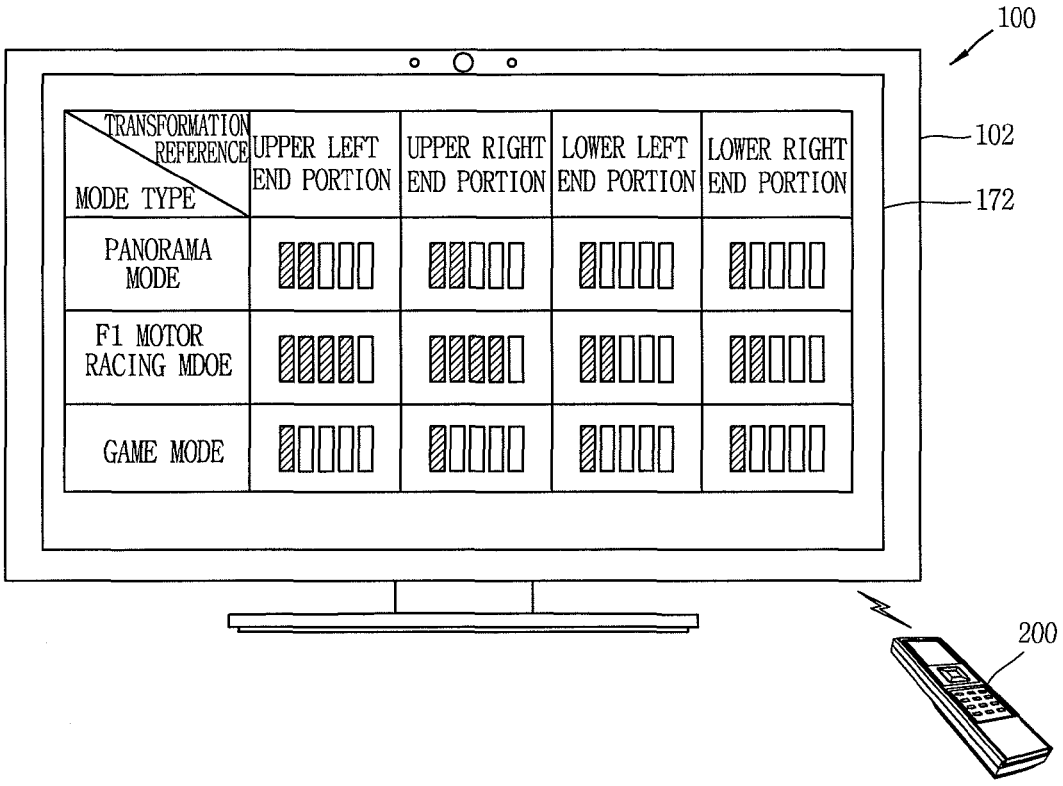
100
102
172
200
TRANSFORMATION REFERENCE
MODE TYPE
UPPER LEFT END PORTION
UPPER RIGHT END PORTION
LOWER LEFT END PORTION
LOWER RIGHT END PORTION
PANORAMA MODE
F1 MOTOR RACING MDOE
GAME MODE

FIG. 16B

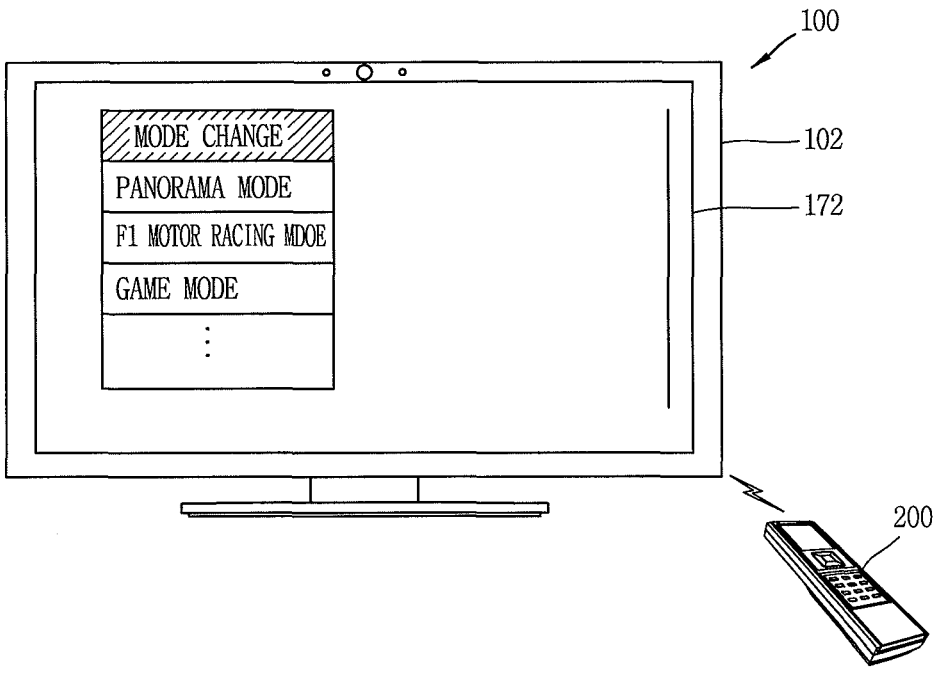
100
MODE CHANGE
PANORAMA MODE
F1 MOTOR RACING MDOE
GAME MODE
102
172
200

FIG. 17

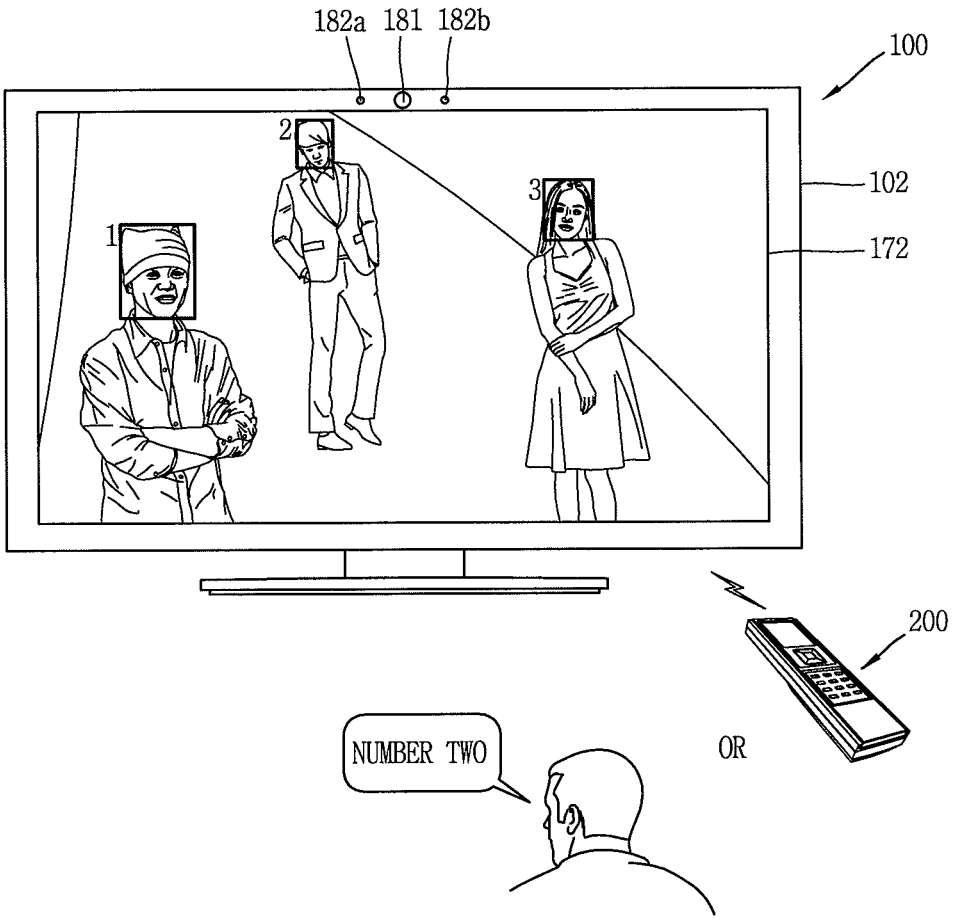

FIG. 18A

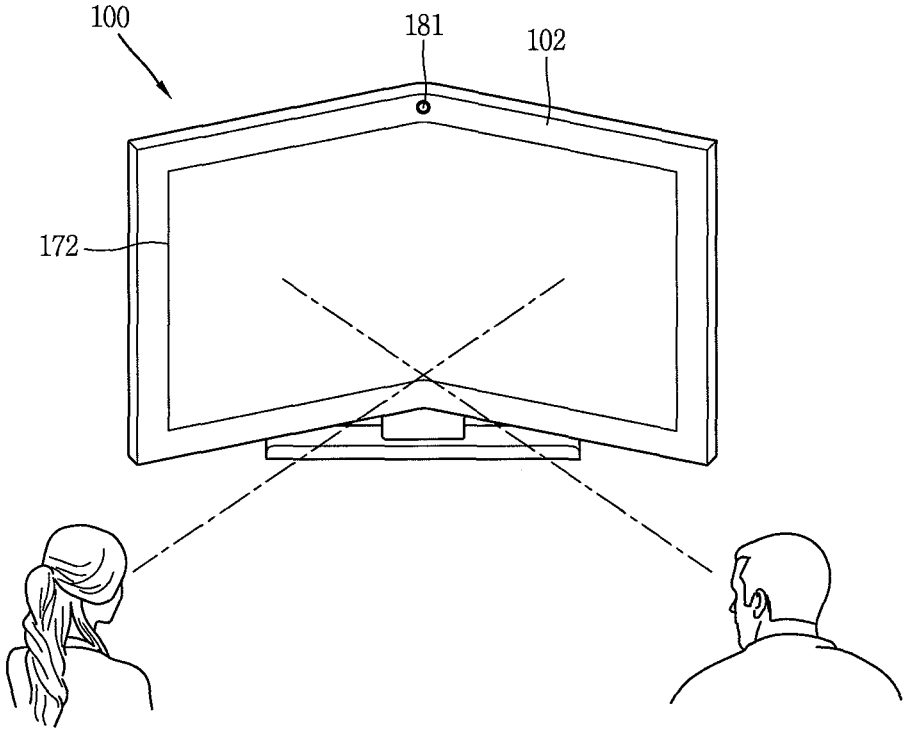

FIG. 18B

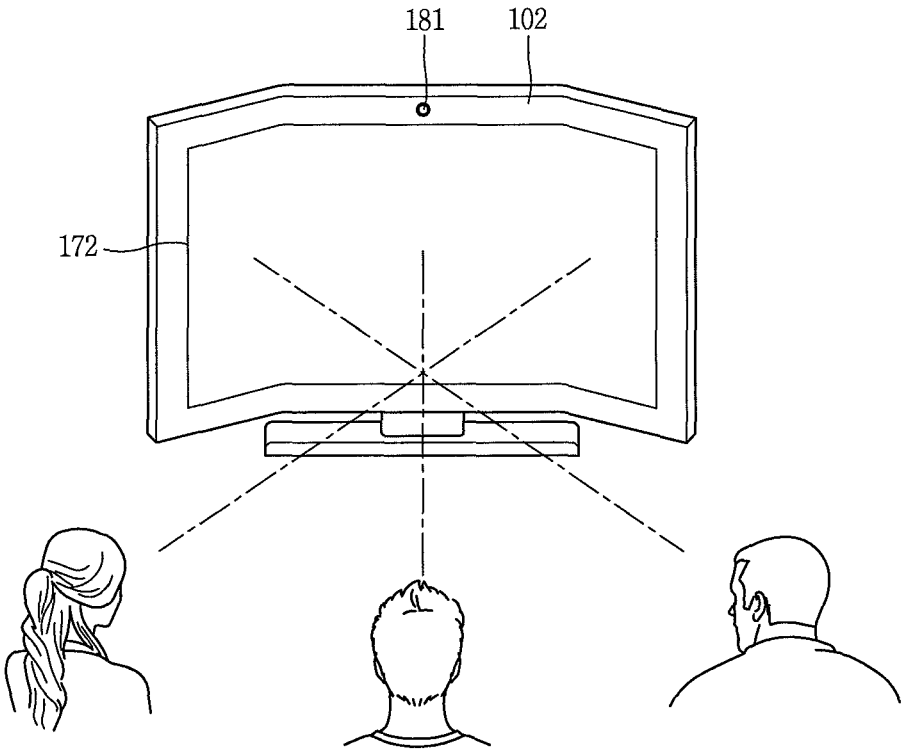

FIG. 19A

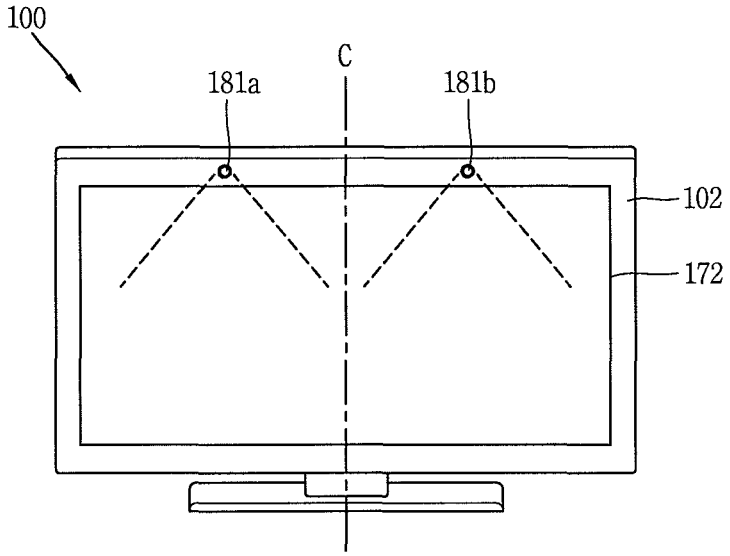

FIG. 19B

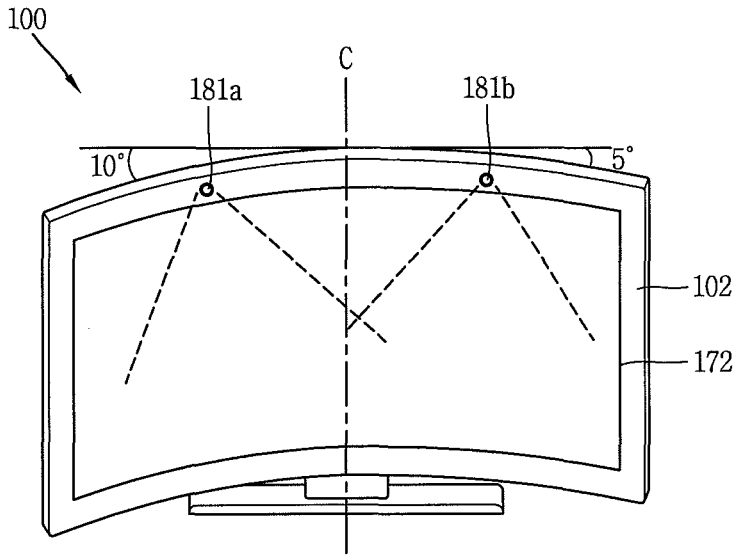

FIG. 20

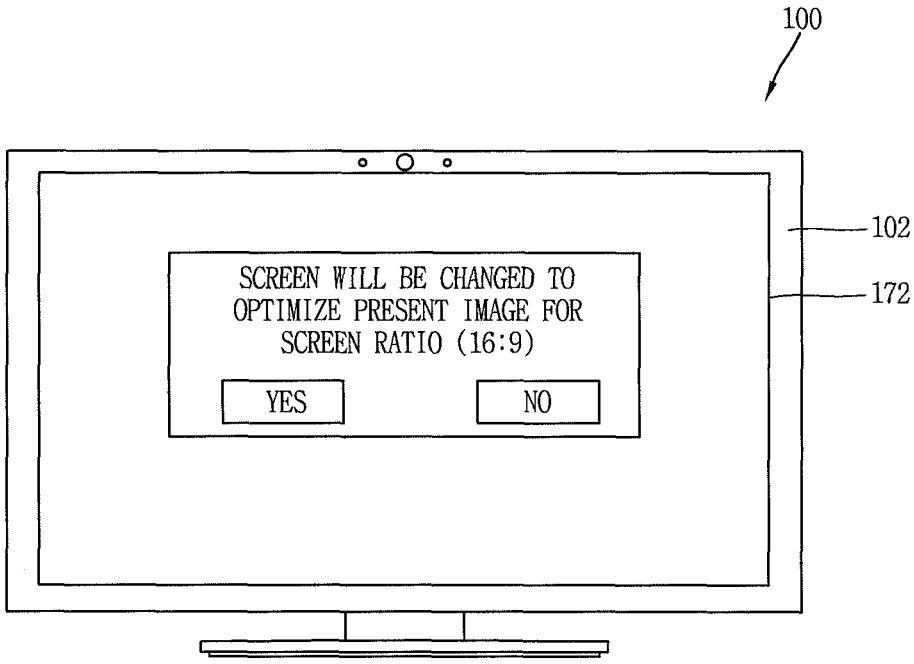
100
102
172
SCREEN WILL BE CHANGED TO
OPTIMIZE PRESENT IMAGE FOR
SCREEN RATIO (16:9)
YES
NO

FIG. 21

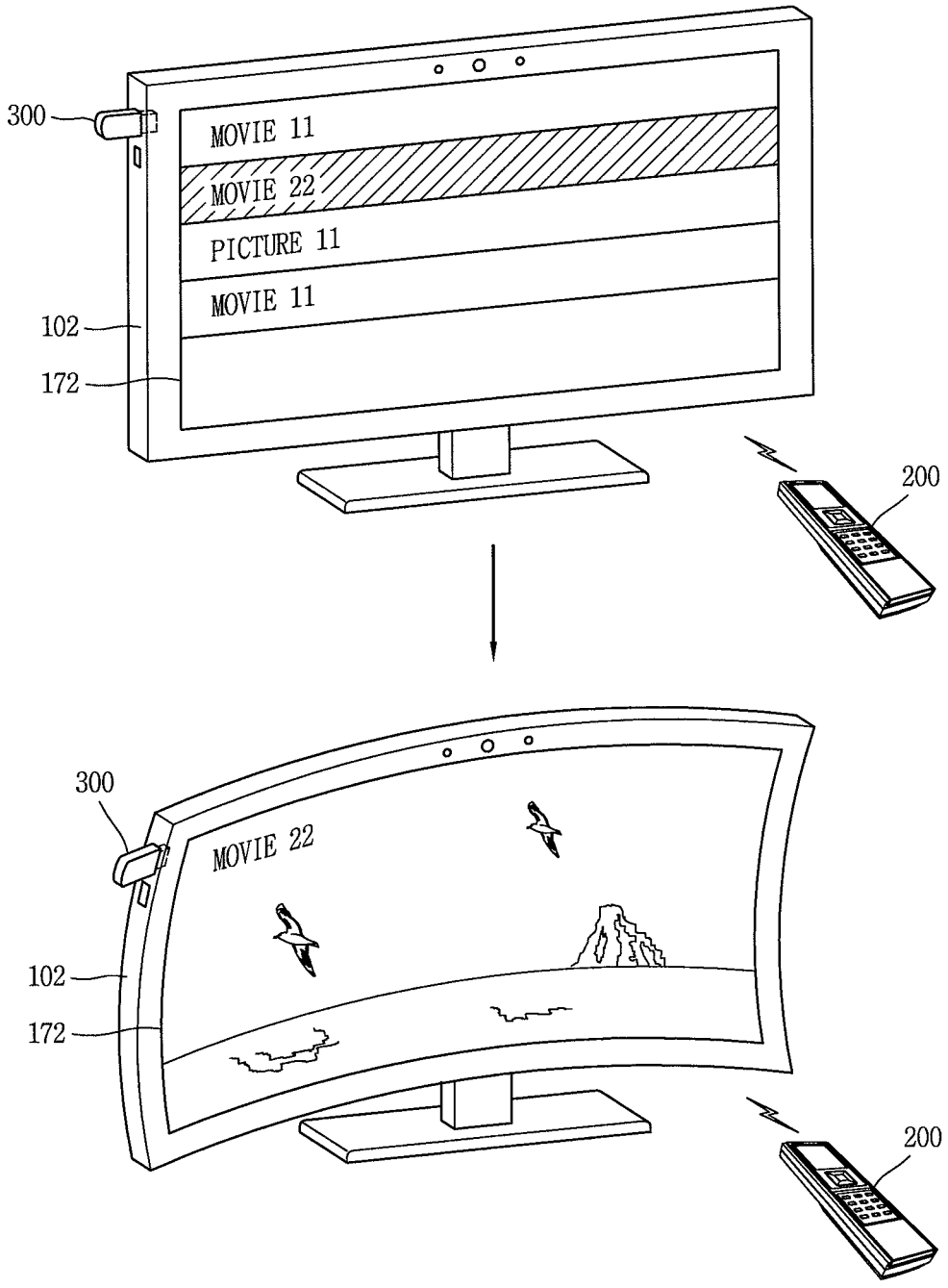
300
MOVIE 11
MOVIE 22
PICTURE 11
MOVIE 11
102
172
200
300
MOVIE 22
102
172
200

IMAGE DISPLAY DEVICE AND METHOD OF CONTROLLING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

Pursuant to 35 U.S.C. §119(a), this application claims the benefit of earlier filing date and right of priority to Korean Application No. 10-2013-0062911, filed on May 31, 2013, the contents of which is incorporated by reference herein in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an image display device, and more particularly to an image display device including a flexible display unit and a method of controlling the image display device.

2. Background of the Invention

An image display device includes a device for recording and playing moving images, and a device for recording and playing audio data. The device for recording and playing audio data includes a TV, a computer monitor, a projector, etc., as an image display device.

As the image display device becomes multifunctional, the image display device can perform capturing still images or moving images, playing music or video files, playing games, receiving broadcast and the like, as well as reproducing music or video files, so as to be implemented as an integrated multimedia player. Many efforts include not only changes and improvement of structural components but also software improvement to support and improve functions of the image display device.

In recent years, an image display device has evolved to provide a variety of designs, and accordingly a flexible display gains popularity for its lightweight and unbreakability characteristics. The flexible display makes possible wider application of a new user interface that is limitedly possible or impossible with the existing glass-based substrate.

SUMMARY OF THE INVENTION

Therefore, an aspect of the detailed description is to provide an image display device that is capable of improving a sense of immersion using characteristics of a flexible display unit that can be bent or be twisted.

To achieve these and other advantages and in accordance with the purpose of this specification, as embodied and broadly described herein, there is provided, an image display device including a main body, a flexible display unit that is arranged on the front side of the main body and is bendable by force, a drive unit that is arranged on the rear side of the flexible display unit and applies the force so as to bend at least one part of the flexible display unit, and a controller that searches for a user location and controls the drive unit so that the at least one part of the flexible display unit is transformed depending on the searched-for user location.

The image display device may further include a camera, in which the controller may search for the user location using an image captured by the camera.

In the image display unit, if the multiple users are searched for on the image, the controller may select at least the one user that serves as a reference in transforming the at least one part of the flexible display unit. In the image display device, tags that are obtained by tagging the multiple users may be output on the flexible display unit, and the controller may cause the at least one user of the tagged users to be selected using the tag associated with at least the one user.

In the image display device, the tags may be numbered in increasing order of the number.

In the image display device, if the user location is searched for, the controller may output the image on the flexible display unit, and may output a graphic object on a position of the user who is searched for on the image.

In the image display device, the controller may change at least one of a position and a size of the graphic object using a signal received from an external input device, and may transform the at least one part of the flexible display unit, based on at least the changed one.

In the image display device, when the transformation of the at least one part of the display unit is completed, the controller may cause the camera to capture an image again in a state where the transformation is completed, and may re-search for the user location using the image that is captured again.

In the image display device, the controller may transform the at least one part of the flexible display unit depending on the researched-for user location.

The image display device may further include first and second microphones, in which the controller may search for the user location using a difference in time between sound signals from the first and second microphones.

In the image display device, the controller control search for the user location using a signal that is received from an external input device.

In the image display device, the controller may output transformation information relating to the flexible display unit on the flexible display unit.

In the image display device, the controller may change the transformation information using information that is received from an external input device and may transform the at least one part of the flexible display unit, based on the changed transformation information.

The image display unit may further include first and second audio output units, in which as the at least one part of the flexible display unit is transformed, the controller can perform control so that amounts of sound that are output from the first and second audio output units are different from each other.

In the image display device, the controller can perform the control so that of the first and second audio output units, one that is positioned closer to the searched-for user outputs a greater amount of sound than the other.

In the image display device, if the user location is searched for, the controller may output information relating on the searched-for user location on the flexible display unit.

In the image display device, the closer the searched-for user location is to the center of the flexible display unit, the greater the curvature may be with respect to the at least one part of the flexible display unit that is transformed.

In the image display device, the controller may bend the at least one part of the flexible display unit so that the at least one part of the flexible display unit is closer to the searched-for user location.

In the image display device, the controller may transform the at least one part of the flexible display unit so that a constant distance is maintained between an entire region of the flexible display unit and the searched-for user location.

In the image display device, when receiving a power-off command, the controller may restore the at least one part of the flexible display unit to its original state.

Further scope of applicability of the present application will become more apparent from the detailed description given hereinafter. However, it should be understood that the

detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from the detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments and together with the description serve to explain the principles of the invention.

In the drawings:

FIG. **1** is a block diagram illustrating an image display apparatus according to an embodiment of the present invention and an external input device;

FIG. **2** is a block diagram illustrating in detail the external input device in FIG. **1**;

FIG. **3** is a diagram illustrating a relationship between operation of the image display device according to an embodiment of the present invention and operation of the external input device;

FIG. **4** is a diagram illustrating a flexible display unit included in the image display device according to one embodiment of the present invention;

FIG. **5** is a vertical cross-sectional diagram of the image display device according to one embodiment of the present invention;

FIG. **6** is a diagram illustrating a structure of a drive unit in the image display device according to one embodiment of the present invention.

FIG. **7** is a flowchart illustrating a method in which the image display device transforms at least one part of the flexible display unit;

FIG. **8** is a diagram illustrating the flowchart in FIG. **7**;

FIGS. **9**A to **9**C are diagrams illustrating the flowchart in FIG. **7**;

FIG. **10** is a diagram illustrating a method in which a user is searched for in the image display device according to one embodiment of the present invention;

FIG. **11** is a diagram illustrating the method in which the user is searched for in the image display device according to one embodiment of the present invention;

FIG. **12** is a diagram illustrating the method in which the user is searched for in the image display device according to one embodiment of the present invention;

FIG. **13** is a diagram illustrating the method in which the user is searched for in the image display device according to one embodiment of the present invention;

FIG. **14** is a diagram illustrating the method in which the user is searched for in the image display device according to one embodiment of the present invention;

FIG. **15** is a diagram illustrating the image display device that outputs transformation information according to the embodiment of the present invention;

FIGS. **16**A and **16**B are diagrams illustrating the image display device that provides various transformation modes according to the embodiment of the present invention;

FIG. **17** is a diagram illustrating the image display device when the multiple users are searched for;

FIGS. **18**A and **18**B are diagrams illustrating when the multiple users are searched for in the image display device according to one embodiment of the present invention;

FIGS. **19**A and **19**B are diagrams illustrating when the camera is included in one end portion of the bent main body;

FIG. **20** is a diagram illustrating the image display device in which a screen ratio of content that is output is considered according to one embodiment of the present invention; and

FIG. **21** is a diagram illustrating the image display device in which the content is considered according to one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Description will now be given in detail according to the embodiments, with reference to the accompanying drawings. The embodiments of the present invention are merely illustrative, and the present invention may be implemented in various forms. For the sake of brief description with reference to the drawings, the same or equivalent components will be provided with the same reference numbers, and description thereof will not be repeated.

In this specification, an image display device may include a device for receiving and displaying broadcast data, a device for recording and playing moving images, and a device for recording and reproducing audio data. Hereinafter, a TV will be described as an example of the image display device.

FIG. **1** is a block diagram illustrating an image display device **100** and an external input device **200** according to an embodiment of the present invention. The image display device **100** may include a tuner **110**, a decoder **120**, a signal input/output unit **130**, an interface **140**, a controller **150**, a storage unit **160**, an output unit **170**, an A/V (audio/video) input unit **180**, a driving unit **190**. The external input device **200** may be a separate device from the image display device **100**, or may be a component of the image display device **100**.

Referring to FIG. **1**, the tuner **110** may select a radio frequency (RF) broadcast signal, which corresponds to a channel selected by a user, among RF broadcast signals received through an antenna, and convert the selected RF broadcast signal into a medium frequency signal or a baseband image (video)/audio signal. For example, when the RF broadcast signal is a digital broadcast signal, the tuner **110** can convert the RF broadcast signal into a digital IF signal (DIF). On the other hand, when the RF broadcast signal is an analog broadcast signal, the tuner **110** can convert the RF broadcast signal into an analog baseband video/audio signal (CVBS/SIF). The tuner **110** may thus be a hybrid tuner which is capable of processing the digital broadcast signal and the analog broadcast signal.

The digital IF signal (DIF) output from the tuner **110** can be input into the decoder **120**, while the analog baseband video/audio signal (CVBS/SIF) output from the tuner **110** can be input into the controller **150**. The tuner **110** can receive a signal carrier RF broadcast signal according to an advanced television systems committee (ATSC) standard or a multi-carrier RF broadcast signal according to a digital video broadcasting (DVB) standard.

Although the drawing illustrates one tuner **110**, the present invention is not limited to this. The image display device **100** may include a plurality of tuners, for example, first and second tuners. In this instance, the first tuner can receive a first RF broadcast signal corresponding to a broadcasting channel selected by a user, and the second tuner can receive a second RF broadcast signal corresponding to a pre-stored broadcasting channel in a sequential or periodical manner. Similar to the first tuner, the second tuner can convert an RF broadcast signal into a digital IF signal (DIF) or an analog baseband video or audio signal (CVBS/SIF).

The decoder **120** can receive the digital IF signal (DIF) converted by the tuner **110** and decode the received signal. For example, when the DIF output from the tuner **110** is a

signal according to the ATSC standard, the decoder **120** can perform 8-vestigal side band (8-VSB) demodulation. Here, the decoder **120** may also perform channel decoding, such as trellis decoding, de-interleaving, reed Solomon decoding and the like. To this end, the decoder **120** may include a trellis decoder, de-interleaver, a reed Solomon decoder and the like.

As another example, when the digital IF signal (DIF) output from the tuner **110** is a signal according to the DVB standard, the decoder **120** can perform a coded orthogonal frequency division modulation (COFDMA) demodulation. Here, the decoder **120** can also perform convolution decoding, de-interleaving, reed Solomon decoding and the like. To this end, the decoder **120** may include a convolution decoder, a de-interleaver, a reed Solomon decoder and the like.

The signal input/output unit **130** can perform signal input and output operations by being connected to an external device. To this end, the signal input/output unit **130** may include an A/V input/output unit and a wireless communication unit.

The A/V input/output unit may include an Ethernet terminal, a USB terminal, a composite video banking sync (CVBS) terminal, a component terminal, a S-video terminal (analog), a digital visual interface (DVI) terminal, a high definition multimedia interface (HDMI) terminal, a mobile high-definition link (MHL) terminal, an RGB terminal, a D-SUB terminal, an IEEE 1394 terminal, a liquid HD terminal and the like. Digital signals input through those terminals may be forwarded to the controller **150**. Here, analog signals input through the CVBS terminal and the S-video terminal may be forwarded to the controller after being converted into digital signals through an analog-digital converter.

The wireless communication unit can execute wireless Internet access. For example, the wireless communication unit can execute the wireless Internet access using wireless LAN (WLAN) (Wi-Fi), wireless broadband (Wibro), world interoperability for microwave access (Wimax), high speed downlink packet access (HSDPA) and the like. The wireless communication unit can also perform short-range wireless communication with other electronic devices. For example, the wireless communication unit can perform short-range wireless communication using Bluetooth, radio frequency identification (RFID), infrared data association (IrDA), ultra wideband (UWB), Zigbee and the like.

The signal input/output unit **130** can transfer to the controller **150** a video signal, an audio signal and a data signal, which are provided from external devices, such as a digital versatile disk (DVD) player, a blu-ray player, a game player, a camcorder, a computer (notebook computer), a portable device, a smart phone and the like. Also, the signal input/output unit **130** may transfer to the controller **150** a video signal, an audio signal and a data signal of various media files, which are stored in an external storage device, such as a memory, a hard disk and the like. In addition, the signal input/output unit **130** can output a video signal, an audio signal and a data signal processed by the controller **150** to other external devices.

The signal input/output unit **130** can perform signal input and output operations by being connected to a set-top box, for example, an Internet protocol TV (IPTV) set-top box via at least one of those various terminals. For instance, the signal input/output unit **130** can transfer to the controller **150** a video signal, an audio signal and a data signal, which has been processed by the IPTV set-top box to enable bidirectional communication, and also transfer signals processed by the controller **150** to the IPTV set-top box. Here, the IPTV may include ADSL-TV, VDSL-TV, FTTH-TV and the like which are divided according to a transmission network.

Digital signals output from the decoder **120** and the signal input/output unit **130** may include a stream signal (TS). The stream signal (TS) may be a signal in which a video signal, an audio signal and a data signal are multiplexed. For example, the stream signal (TS) may be an MPEG-2 transport stream (TS) signal obtained by multiplexing an MPEG-2 video signal and a Dolby AC-3 audio signal. An MPEG-2 TS signal may include a 4-byte header and a 184-byte payload.

The interface **140** can receive an input signal for power control, channel selection, screen setting or the like from an external input device **200** or transmit a signal processed by the controller **150** to the external input device **200**. The interface **140** and the external input device **200** may be connected to each other in a wired or wireless manner.

As an example of the interface unit **140**, a sensor may be provided. The sensor may be implemented as a remote controller to sense the input signal.

A network interface unit provides an interface for connecting the image display device **100** with a wired/wireless network including an internet network. The network interface unit may be provided with an Ethernet terminal, etc., for connection with a wired network. For connection with a wireless network, WLAN (Wireless LAN) (Wi-Fi), Wibro (Wireless broadband), Wimax (World Interoperability for Microwave Access), HSDPA (high speed downlink packet access), etc., may be used.

The network interface unit can access a prescribed web page through a network. That is, the network interface unit can transceive (transmit and receive) data with a corresponding server. The network interface unit can receive content or data provided from a content provider or a network operator. That is, the network interface unit can receive contents such as movies, advertisements, games, VOD, and broadcast signals provided from a content provider or a network provider through a network, and information related thereto.

The network interface unit can receive update information and update files provided from a network operator. The network interface unit can transmit data to an Internet provider, a content provider or a network operator. The network interface unit can select and receive a desired application among applications open to the public, through a network.

The controller **150** can control an overall operation of the display device **100**. More specifically, the controller **150** can control generation and output of images. For example, the controller **150** can control the tuner **110** to tune an RF broadcast signal corresponding to a user-selected channel or a pre-stored channel. Further, the controller **150** may include a demultiplexer, a video processor, an audio processor, a data processor, an On screen display (OSD) generator and the like. The controller **150** may include a CPU, a peripheral device, etc., by hardware.

The controller **150** may demultiplex a stream signal (TS), e.g., an MPEG-2 TS signal into a video signal, an audio signal and a data signal. Further, the controller **150** performs image processing, for example, decoding, on an inversely-multiplexed image signal. More specifically, the controller **150** decodes an MPEG-2 standard-encoded image signal by using an MPEG-2 decoder, and decodes an H.264 standard-encoded image signal according to digital multimedia broadcasting (DMB) standard or digital video broadcast-handheld (DVB-H) standards by using an H.264 decoder.

In addition, the controller **150** can perform the imaging processing so that brightness, tint and color of the image signal are adjusted. The image signal, which is image-processed by the controller **150**, may be transferred to the display unit **172** or transferred to an external output device through an external output port.

The controller **150** can perform, voice processing, for example, decoding, on an inversely multiplexed voice signal. More specifically, the controller **150** decodes an MPEG-2 standard-encoded voice signal by using an MPEG-2 decoder, decodes an MPEG 4 bit sliced arithmetic coding (BSAC) standard-encoded voice signal according to the DMB standards by using an MPEG 4 decoder, and decodes an MPEG 2 advanced audio coded (AAC) standard-encoded voice signal according to satellite DMB standards or the digital video broadcast-handheld (DVB-H) standards by using an AAC decoder. In addition, the controller **150** can perform base processing, treble processing, and sound volume processing. The voice signal processed by the controller **150** can be transferred to an audio output unit **171**, e.g., a speaker, or may be transferred to an external out device.

The controller **150** can process an analog baseband video/audio signal (CVBS/SIF). Here, the analog baseband video/audio signal (CVBS/SIF) input to the controller **150** may be an analog baseband video/audio signal output from the tuner **110** or the signal input/output unit **130**. The processed video signal is displayed on the display unit **172**, and the processed audio signal is output through the audio output unit **171**.

The controller **150** can process, for example, decode a demultiplexed data signal. Here, the data signal may include electronic program guide (EPG) information, which may include broadcast information, such as start time, end time and the like, related to a broadcast program broadcasted on each channel. The EPG information may include ATSC-program and system information protocol (ATSC-PSIP) information and DVB-service information (DVB-SI) information. The ATSC-PSIP information or DVB-SI information may be included in an MPEG-4 TS header (4 bytes).

The controller **150** can perform on-screen display (OSD) processing. In more detail, the controller **150** can generate an OSD signal for displaying various information as graphic or text data based on at least one of a video signal and a data signal or an input signal received from the external input device **200**. The OSD signal may include various data such as a user-interface (UI) screen for the image display device **100** and various menu screens, widgets, icons and the like.

The storage unit **160** can store various programs for signal processing and control by the controller **150**, and may also store processed video, audio and data signals. The storage unit **160** may include at least one of a flash memory-type storage medium, a hard disc-type storage medium, a multimedia card micro-type storage medium, a card-type memory (for example, SD or XD memory), a random access memory (RAM), a read-only memory (ROM), electrically erasable programmable ROM (EEPROM), a magnetic memory, a magnetic disk and an optical disk.

The output unit **170** is configured to generate output of data in a visible manner, in an audible manner, etc. The output unit **170** includes the audio output unit **171** and the display unit **172**. Further, the audio output unit **171** outputs a voice signal processed by the controller **150**, e.g., a stereo signal or a 5.1-channel signal. The audio output unit **171** may be implemented in various types of speakers.

The display unit **172** can convert a processed video signal, a processed data signal, and an OSD signal provided by the controller **150** into RGB signals, thereby generating driving signals. Under such configuration, the display unit **172** outputs images. The display unit **172** may be implemented into various types of displays such as a plasma display panel, a liquid crystal display (LCD), a thin film transistor-LCD (TFT-LCD), an organic light-emitting diode (OLED), a flexible display, a three-dimensional (3D) display, an e-ink display and the like. The display unit **172** may also be implemented as a touch screen and may thus be used as an input device.

The A/V input unit **180** is configured to receive an audio or video signal, and may include a camera **181**, a microphone **182**, etc. The camera **181** processes image frames such as still images or moving images acquired by an image sensor in a video capturing mode or an image capturing mode. The processed image frames may be displayed on the display unit **172**.

The image frames processed by the camera **181** may be stored in the memory **160** or transmitted via a radio communication unit. Two or more cameras **181** may be provided according to a user environment. The camera **181** can also capture a user. The camera **181** may be implemented as a single camera or a plurality of cameras. Information on images captured by the camera **181** is input to the controller **150**.

For sensing of a user's gesture, a sensing unit, having at least one of a touch sensor, a sound sensor, a position sensor and an operation sensor, may be further provided at the image display device **100**. A signal sensed by the sensing unit can be transferred to the controller **150** through the interface unit **140**. The controller **150** can sense a user's gesture based on images captured by the camera **181**, or based on signals sensed by the sensing unit, or by combination of them.

The microphone **182** receives sounds (audible data) via a microphone in a phone call mode, a recording mode, a voice recognition mode, and the like, and processes such sounds into electric voice data. The microphone **182** may implement various types of noise canceling (or suppression) algorithms to cancel (or suppress) noise or interference generated when receiving and transmitting audio signals.

When the display unit **170** is implemented as a flexible display, the driving unit **190** applies a force so that at least part of the flexible display can be transformed. A method for applying a force will be explained with reference to FIGS. **5** and **7**.

A power supply unit supplies electric power to the image display device **100**. Specifically, the power supply unit supplies electric power to the controller **150** that is realized in the form of a system-on chip (SOC), the display unit **172** for displaying an image, and the audio output unit **171** for outputting audio.

To do this, the power supply unit may include a converter that converts DC power into AC power. For example, if the display unit **172** is realized as a liquid crystal panel including multiple backlight lamps, the power supply unit may further include an inverter in which a PWM operation is possible for brightness variability and dimming drive.

The external input device **200** is connected to the interface unit **140** by a cable or wirelessly, and transmits an input signal that is generated according to a user input, to the interface unit **140**. The external input device **200** may include a remote controller, a mouse, a keyboard, and the like. The remote controller transmits an input signal to the interface unit **140** by using Bluetooth communication, RF communication, IR communication, ultra wideband (UWB) communication, ZigBee communication, or the like. The remote controller may be implemented as a spatial remote controller. The spatial remote controller may generate an input signal by detecting a movement of a main body.

The image display device **100** may be realized as a fixed type digital broadcast receiver for receiving at least one of an ATSC type (8-VSB type) digital broadcast, a digital broadcast, a DVB-T type (COFDM type) digital broadcast, and an ISDB-T type (BST-OFDM type) digital broadcast. Alternatively, the image display device **100** may be realized as a

mobile type digital broadcast receiver for receiving at least one of a ground wave DMB type digital broadcast, a satellite DMB type digital broadcast, an ATSC-M/H type digital broadcast, a DVB-H type (COFEM type) digital broadcast, and a media forward link-only type digital broadcast. Alternatively, the image display apparatus **100** may be implemented as a digital broadcast receiver for cable communication, satellite communication or IPTV.

Next, FIG. **2** is a block diagram illustrating the external input device **200** of FIG. **1** in detail. The external input device **200** includes a wireless communication unit **210**, a user input unit **220**, a sensing unit **230**, an output unit **240**, a power supply unit **250**, a storage unit **260** and a controller **270**.

Referring to FIG. **2**, the wireless communication unit **210** can transmit a signal to the image display device **100** or receive a signal from the image display device **100**. To this end, the wireless communication unit **210** includes an RF module **211** and an IR module **212**. The RF module **211** may transmit and receive signals according to an RF communication standard by being connected to the interface **140** of the image display device **100**. The IF module **212** can transmit and receive signals according to an IF communication standard by being connected to the interface **140** of the image display device **100**.

The user input unit **220** may include as an input element a keypad, a key button, a scroll key, a jog key and the like. The user may manipulate the user input unit **220** to input (enter) commands (instructions) related to the image display device **100**. The command, for example, may be entered as a user pushes a hard key button of the user input unit **200**.

The sensing unit **230** may include a gyro sensor **231** and an acceleration sensor **232**. The gyro sensor **231** may sense a spatial movement of the external input device **200** based on X, Y and Z axes. The acceleration sensor **232** may sense a moving speed of the external input device **200** and the like.

The output unit **240** may output information in response to manipulation of the user input unit **230** and information corresponding to a signal sent by the image display device **100**. Therefore, a user can recognize a manipulation state of the user input unit **230** or a control state of the image display device **100** through the output unit **230**. For example, the output unit **240** may include an LED module **241** which is turned on and off, a vibration module **242** which generates vibration, an audio output module **243** which outputs sound, and a display module **244** which outputs images, in response to manipulation of the user input unit **230** or transmission and reception of signals through the wireless communication unit **210**.

The power supply unit **250** can supply power to various electronic elements of the external input device **200**. The power supply of the power supply unit **250** may be stopped when the external input device **200** does not move for a predetermined time, thereby reducing power consumption. The power supply unit **250** may resupply power when a predetermined key of the external input device **200** is manipulated.

The storage unit **260** can store various programs, which are involved with control and operations of the external input device **200**, applications, frequency band information and the like. The controller **270** may execute an overall control operation of the external input device **200**.

FIG. **3** is a conceptual view illustrating reciprocal operations of the image display device **100** and the external input device **200** according to an embodiment of the present invention. The image display device **100** is implemented as a TV receiver, and the external input device **200** is implemented as a remote controller.

Referring to FIG. **3**, the external input device **200** can transmit and receive a signal to/from the image display device **100** according to an RF communication standard. A control menu may be displayed on a screen of the image display device **100** according to a control signal of the external input device **200**. The external input device **200** may be provided with a plurality of buttons, and may generate an external input signal according to a user's operation to manipulate buttons.

If the display unit **170** is configured from a flexible display, the drive unit **190** applies force so that at least one part of the flexible display is transformed.

An image display device **100** according to the embodiment of the present invention is illustrated as including one camera **181** and the multiple microphones **182***a* and **182***b* in FIG. **3**, but this corresponds to one embodiment. That is, depending on the embodiment, one camera **181** may be provided or may not be provided, and depending on the embodiment, at least one microphone **182** may be provided or may not be provided.

On the other hand, according to an embodiment of the present invention, information processed by the image display device **100** is displayed using the flexible display. A flexible display unit is described in detail below referring to the accompanying drawings. FIG. **4** is a diagram illustrating a flexible display unit **172** included in an image display device **100** according to one embodiment of the present invention.

As illustrated in FIG. **4**, the flexible display unit **172** includes a display that can be by force bent, warped, folded, or rolled. Further, the flexible display unit **172** includes both a general flexible display and electronic paper.

In more detail, the general flexible display corresponds to a lightweight, unbreakable, robust display which is manufactured using a flexible substrate that can be bent, warped, folded, or rolled like a sheet of paper, and which still maintains display characteristics of the existing flat display.

In addition, the electronic paper results from application of a display technology using general characteristics of ink and differs from a general flat display in that it uses reflection right. The electronic paper changes pictures and letters using electrophoresis using a capsule, or using a twist ball.

Further, the sensing unit **151** (refer to FIG. **1**) is included in the flexible display unit **172** and thus detects information relating to a bent state of the flexible display unit **172**. The word "bent" in the present specification means "being warped." "being rolled," "being folded," or "being curved," for example.

The sensing unit **151** is arranged on the entire flexible display unit **172** or on a portion of the flexible display unit **172** and detects the information relating to the bent state of the flexible display unit **172**. Further, the information relating to the bent state of the flexible display unit **172** includes a bending direction, bending extent, and a bending position of the flexible display unit **172** and acceleration at which the bent flexible display unit returns back to its original shape, and further includes various types of information that can be detected in relation to the bent state of the flexible display unit.

In addition, the controller **150** changes information displayed on the flexible display unit **172** or generates a control signal for controlling a function performed by the image display device **100**, based on the information relating to the bent state of the flexible display unit **172** detected by the sensing unit **151**.

For example, if the flexible display unit **172** is bent by force as illustrated in FIG. **4**, the controller **150** rearranges, separates, or combines screen images already displayed on the flexible display unit **172** or changes a curvature, depending on the bending direction and a bending angle of the flexible

display unit **172** and the returning acceleration at which the bent flexible display unit returns back to its original shape.

As one example, if the flexible display unit **172** is bent inward by force as illustrated in FIG. **4**, the controller **150** causes the images displayed on the flexible display unit **172** to be displayed so as to get close to one another. In addition, conversely, if the flexible display unit **172** is bent outward by force, the screen images displayed on the flexible display unit **172** are displayed so as to move away from one another.

In addition to the ways above described, the controller **150** variously controls the way to display the information on the flexible display unit **172** so the user accurately can recognize the information displayed on the flexible display unit **172**, corresponding to the bent state of the flexible display unit.

Then, the image display device **100** according to an embodiment of the present invention that includes the flexible display unit **172** that encloses the flexible display unit **172** as illustrated in FIG. **4**. In addition, the main body **102** is configured considering characteristics of the flexible display unit **172**, so the main body **102** is bent by external physical force together with the flexible display unit **172**.

Further, the image display device **100** according to an embodiment of the present invention transforms at least one part of the flexible display unit **172** using the drive unit **190** (refer to FIG. **1**). The drive unit **190** is described in more detail below referring to FIGS. **5** and **7**.

FIG. **5** is a vertical cross-sectional diagram of the image display device **100** according to one embodiment of the present invention. Referring to FIG. **5**, in the image display device **100**, the drive unit **190** is positioned between the flexible display unit **172** and the main body **102**. The drive unit **190** is positioned in at least one region between the flexible display unit **172** and the main body **102** and at least one drive unit **190** is provided in various directions in which the flexible display unit **172** is transformed.

In addition, a touch input unit is further provided on the front side or the rear side of the flexible display unit **172** to receive a touch input from the user. Then, a back cover is formed on the rear side of the flexible display unit **172** to prevent the flexible display unit **172** from warping. For example, the back cover is made of material such as carbon fiber reinforced plastics (CFRP), or is in the shape such as a honeycomb, and this prevents the flexible display unit **172** from warping and transfers force to the flexible display unit **172**, resulting in providing suitable bending. Because the back cover can also be bent, the drive unit **190** is formed on the rear side of the back cover and transforms the flexible display unit **172**.

The drive unit **190** is a constituent element for transforming at least one part of the flexible display unit **172**. The drive unit **190** includes a thermal transformation member, a motor, a shape-memory alloy, and an ionic layer. That is, the drive unit **190** includes all constituent elements for applying force to at least one part of the flexible display unit **172**.

According to the embodiment, the thermal transformation member is formed on the rear side of the flexible display unit **172** by applying a coating material to the rear side of the flexible display unit **172**, or is formed on the rear side of the flexible display unit **172** by laminating a thin film formed in the shape of a band on the rear side of the flexible display unit **172**. Force is applied to the flexible display unit **172** by providing heating or cooling to the thermal transformation member.

A bimetal is used as one example of the thermal transformation member. The bimetal is made by stacking two metals, each with a different thermal expansion coefficient. When heat is applied to the bimetal and thus temperature of the bimetal is increased, the bimetal is bent to the metal with the lower thermal expansion coefficient and thereafter when the temperature is decreased, the bimetal returns to its original state. An alloy of nickel and iron is used as the metal with the lower thermal expansion coefficient, that is, a metal that is not well expandable. An alloy of nickel and manganese, and iron, an alloy of nickel and manganese, and copper, or an alloy of nickel and molybdenum, and iron, is used as the metal with the higher thermal expansion coefficient, that is, a metal that is well expandable.

According to the embodiment, the drive unit **190** is configured from the ionic layer. As one example of the ionic layer, an ionic polymer-metal composite layer (an IPMC layer) is used. The ionic polymer-metal composite layer changes in shape depending on an applied voltage. As the ionic polymer-metal composite layer changes in shape, force is applied to at least one part of the flexible display unit **172**.

In association with the drive unit **190**, a case is described above in which the thermal transformation member of which the length is transformed by heat and the ionic polymer-metal composite layer that contracts and expands depending on the applied voltage are used, but the present invention is not limited to the case described above. For example, the drive unit **190** may be formed so that the drive unit **190** has a structure in which the flexible display unit **172** is transformed using rotatory power produced by the motor, or the flexible display unit **172** is transformed by causing an air bag to expand or contract using pneumatic pressure.

Next, FIG. **6** is a diagram illustrating the structure of the drive unit **190** in the image display device **100** according to one embodiment of the present invention. According to the embodiment, the drive unit **190**, the multiple drive units **190**, each of which is described above referring to FIG. **5**, are formed in the shape of a lattice (each drive unit **190** is in the shape of a cell) and are installed on the rear side of the flexible display unit **172**. Then, the controller **190** controls each of the multiple drive units and thus arbitrarily transforms a shape of the flexible display unit **172**.

That is, the controller **150** causes the drive units **190** to operate in a unit of a cell, in a unit of a row, or in a unit of a column. Then, the controller **150** sets a basic axis that serves as a basis for transformation, and thus variously transforms the flexible display unit **172**. For example, the controller **150** sets both of the first column and the first row to be the basic axis and transforms only a portion of the display unit **172** that corresponds to "1A." As another example, the controller **150** sets the second column to be the basic axis and makes division into the left portion and the right portion with the second column as the basic axis. Thus, the controller **150** bends the left portion and the right portion at different angles.

A method in which the image display device **100** described above transforms at least one part of the flexible display unit **172** is described in more detail below referring to the accompanying drawings. FIG. **7** is a flowchart illustrating the method in which the image display device **100** transforms at least one part of the flexible display unit **172**. FIG. **8** and FIGS. **9**A to **9**C are diagrams illustrating the flowchart in FIG. **7**.

First, the controller **150** searches for a user location (S**110**). The user means at least one person who is positioned within a short distance to watch the image display device **100**. A method of searching for the user, for example, includes a method of analyzing an image captured by the camera, a method of analyzing a difference in time between audio signals received through the first and second microphones, and a method of analyzing a signal received from an external

device. The method of searching for the user is described in detail below referring to FIGS. **11** to **13**.

On the other hand, only when an event occurs, the controller **150** searches for the user location in order to search for the user location in real time or efficiently consume electric power. Further, the "event" is when at least one part of the flexible display unit **172** has to be transformed, such as when the electric power is applied to the powered-off image display device **100** and thus the image display device is powered on, when a control command for performing a transformation function is input, or when a predetermined period set for searching for the user repeats (for example, when 30 minutes has elapsed after searching for the user).

When the user is searched for, at least one part of the flexible display unit **172** is transformed depending on the searched-for user location (S**120**). That is, the controller **150** determines whether or not to transform at least one part of the flexible display unit **172**, depending on whether or not the user is searched for. That is, if the user is searched for by using flexibility characteristics of the flexible display unit **172**, the controller **172** transforms the flexible display unit **172**, based on the searched-for user location.

At this point, a transformation state of the flexible display unit **172** varies depending on the user location. That is, at least one of a transformation portion of the flexible display unit **172**, a transformation direction and an extent of transformation varies depending on the user location, and the extent of transformation is numerically expressed depending on a curvature or a bending angle.

The transformation state dependent on the user location is calculated by the controller **150** or is stored in the storage unit **160** (refer to FIG. **1**). If the transformation state dependent on the user location is stored in the storage unit **160**, the transformation state is set to be a state of providing a sense of a suitable immersion at the user location. The contents that are to be stored in the storage unit **150** is stored by a manufacturer at the time of shipment and is edited or updated by the manufacturer or the user.

Next, FIG. **8** is a diagram illustrating the transformation state of the flexible display unit **172** that varies depending on a distance from the image display device **100** according to the embodiment of the present invention to the user. If the searched-for user "u" is positioned in a straight line with the center "c" of the mobile terminal, the transformation state of the flexible display unit **172** varies depending on a distance between the center "c" of the mobile terminal and the searched-for user "u."

In order for the flexible display unit **172** to get bent in the shape of a curved surface similar to that of a human eye, the closer the searched-for location of the user "u" is to the display unit **172**, the greater the curvature has to be with respect to at least one part of the flexible display unit **172**. That is, the farther the searched-for user location is away from the image display device **100**, the smaller the curvature is with respect to at least one part of the flexible display unit **172**. It is apparent from FIG. **8** that because "L**1**" is smaller than "L**2**," the flexible display unit **172** is transformed to a greater curvature in the case of "L**1**" than in the case of "L**2**."

Referring to FIG. **9**A, the controller **150** transforms at least one part of the flexible display unit **172** so that a constant distance is maintained between an entire region of the flexible display unit **172** and the searched-for location of the user "u". Accordingly, a phenomenon in which recognizability of the edge portion is decreased is reduced because an area of a screen that is recognized by the human eye increases and a distance from the human eye to the center "c" of the screen becomes the same as a distance from the human eye to the lateral side.

Referring to FIGS. **9**A and **9**B, even though the distance between the searched-for user "u" and the center "c" of the image display device **100** is the same as the distance from the human eye to the lateral side, the transformation state of the flexible display unit **172** varies depending on where the searched-for user "u" is.

In addition, referring to FIG. **9**C, the controller **150** bends the flexible display unit **172** so that at least one part of the flexible display unit **172** gets closer to the searched-for location of the user "u". That is, one region, not the entire region, of the flexible display unit **172** is transformed. This is done to create the state of providing the sense of the suitable immersion.

The transforming of at least one part of the flexible display unit **172** in a direction parallel to the ground is described above, but the flexible display unit **172** can be transformed not only in the direction parallel to the ground, but also in the direction vertical to the ground. That is, the flexible display unit **172** can be transformed in various directions by the drive unit **190** (refer to FIG. **1**).

A method in which the image display device **100** described above searches for the user is described in more detail below referring to FIGS. **10** to **14**.

FIG. **10** is a diagram illustrating the image display device **100** in the case of an occurrence of the event described referring to FIG. **7**. Referring to FIG. **10**, if an event for transforming the flexible display unit **172** (for example, a power-on event) occurs, the controller **150** according to an embodiment of the present invention outputs a pop-up window that is dependent on the occurrence of the event. At this point, a "best mode" means a mode in which at least one part of the flexible display unit **172** is transformed or will be transformed so as to provide the feel of suitable immersion at the user location.

By responding to the pop-up window, the user determines whether or not at least one part of the flexible display unit **172** is selectively transformed. At this point, the user uses various input methods. For example, the user inputs "Yes," or "No" using voice recognition or provides an input using the external input device **200** (refer to FIG. **1**). If the flexible display unit **172** is configured from a touch screen, the user uses the touch input. This is done to check whether or not the user desires to be provided with an environment in which the flexible display can provide an improved sense of immersion.

FIG. **11** is a diagram illustrating a method of searching for the user using the camera according to the embodiment. Referring to FIG. **11**, the controller **150** captures an image using the camera **181** of the image display device **100** which searches for the user using the captured image. For example, a region that is presumed to be a face is searched for using a distinctive portion of the face such as an eye, a nose, and a mouth, and the searched-for region is determined to correspond to the user location. In embodiments of the present invention, the camera **181** can be mounted on the main body **102**. However, such is not required, and the camera **181** can be included in any portion of the image display device **100**, including the flexible display unit **172**. Also, in embodiments of the present invention, the microphone **182** can be mounted on the main body **102**. However, such is not required, and the microphone **182** can be included in any portion of the image display device **100**, including the flexible display unit **172**.

The searched-for user location is calculated using a size and a location of the region that is presumed to be the face in

the entire image captured by the camera **181**. At this point, two or more of the cameras are used to make a more precise search.

Then, the controller **150** searches for the eyes of the user and bends at least one part of the flexible display unit **172** considering a field of view that is dependent on the location of the eyes. That is, the flexible display unit **172** is bent so that the field of view covers a broader area.

Further, if the user is searched for, the controller **150** outputs the image captured by the camera **181** on the flexible display unit **172** and outputs a graphic object **312** to the searched-for user location along with the image. The user can check whether or not the precise search is made, using the image and the graphic object **312** that are output.

Furthermore, the controller **150** outputs information **314** on the searched-for user location to the flexible display unit **172**. The location information includes information relating to the distance between the image display device **100** and the user and to the direction in which the user is searched for with respect to the image display device **100**. The user location **314** and location "DEVICE" of the image display device are visually output using a picture (hereinafter referred to as a "map") in which a space is scaled down and is expressed in one plane.

In addition, the controller **150** outputs a menu **316** corresponding to the location information along with the location information. For example, the menu **316** includes at least one of "check," "search again," and "adjust."

The "check" is a menu for approving the transformation of the flexible display unit **172**, based on the searched-for user location, and the "search again" is a menu for searching for the user location once more. The "adjust" is a menu for changing the searched-for user location.

When the "adjust" menu is selected, the user location is adjusted in a state where the map and the user location are output. For example, the user location **314** that is output on the map is moved using a wheel or a directional button of the external input device **200**. As another example, if the flexible display unit **172** is configured from the touch screen, the user location is moved to a point at which the touch input is received and a point that corresponds on the map.

Additionally, referring to FIG. **12**, the user location is adjusted using the graphic object **312** that is output along with the image. For example, the "adjust" menu is selected, the flexible display unit **172** outputs the graphic object **312** along with the image, and at this point, the user can change at least one of a location and a size of the graphic object using the wheel and the directional button of the external input device **200** (**312**->**312'**).

Further, the controller **150** transforms the flexible display unit **172**, based on the user location **312'** that results from the adjustment by the user input, not on the user location **312** searched for by the controller **150**.

When the user location is confirmed, the controller **180** transforms at least one part of the flexible display unit **172**, based on the confirmed user location. When the transformation of the flexible display unit **172** is completed, the controller **150** outputs transformation information **318** relating to the flexible display unit **172** on the flexible display unit **172**. The transformation information means information relating to the transformation portion of the edge portion of the flexible display unit **172**, the transformation direction, and the extent of transformation, and the extent of transformation is numerically expressed depending on the curvature and the bending angle.

Next, FIG. **13** is a diagram illustrating a method in which the user is searched for using first and second microphones **182***a* and **182***b*, according to the embodiment. At least two of the image display devices **100** according to an embodiment of the present invention are arranged on the main body **102**. The first and second microphones **182***a* and **182***b* are arranged with spacing in between, and the controller **150** searches for the user using audio signals received in the first and second microphones **182***a* and **182***b*.

Because the first and second microphones **182***a* and **182***b* are arranged with the spacing in between, the audio signals generated at the same point are received in the first and second microphones **182***a* and **182***b* at different times. Because a speed of sound is constant, the user location is searched for using delay in time between the audio signals received in the first and second microphones **182***a* and **182***b*.

Further, the controller **150** outputs a guide message (for example, "Give a big hand!") for providing the more precise search. In a state in which the guide message is output, the user is searched for with more precision using the audio signal that is received within a reference time.

FIG. **17** is a diagram illustrating a method in which the user is searched for using the external input device **200**, according to the embodiment. The external input device **200** includes any device that transmits a control signal to the image display device **100**, and a remote controller and the mobile terminal are examples of the external input device **200**. Because the control signal transmitted using infrared rays, the location from which the infrared rays are emitted is determined to be the user location. Also, the controller **150** outputs the guide message (for example, "Input a signal!") for providing the more precise search.

As described above, the image display device **100** according to an embodiment of the present invention searches for the user using the camera, the microphone, or the external input device. In addition, the controller **150** searches for the user by combining the methods described above referring to FIGS. **11** to **14** in order to improve the precision of the search. In this instance, the search for the user is performed with more precision by weighting the methods.

The image display device **100** outputting the transformation information according to the embodiment of the present invention is described below referring to FIG. **15**. Referring to FIG. **15**, the transformation information relating to the "best mode" that is dependent on the searched-for user location is illustrated on the flexible display unit **172**. That is, the controller **150** outputs the transformation information relating to the flexible display unit **172** for providing the sense of suitable immersion at the user location.

According to the transformation information illustrated in FIG. **15**, the best mode is such that at the searched-for user location, the left and right edge portions are bent by three degrees compared to an initial state in which the transformation does not occur and the upper and lower edge portions are bent by four degrees compared to the initial state. The user can check the bent portion of the image display device, the bending direction, and the extent of the bending.

On the other hand, the transformation information includes a maximum value information indicating the maximum possible extent of transformation. For example, a maximum value ranging from "−15" to "+15" is output with respect to the left and right edge portions. The plus sign and the minus sign indicate the directions of transformation.

In addition, the user can use the transformation information using the external input device **200**. For example, at least one part of the flexible display unit **172** that is intended to be transformed is selected using the directional key provided on the external input device **200** and at least one of the direction

in which the selected one part is transformed and the extent (size) to which the elected one part is transformed is changed.

The one part of the flexible display unit **172** that is intended to be transformed is at least one of the upper, lower, left, and right edge portions of the flexible display unit **172**, or when the drive units **190** (refer to FIG. **9**) are configured in the shape of multiple cells, is at least one of the multiple cells.

Accordingly, the flexible display unit **172** of the image display device **100** can be transformed as the user desires. Furthermore, in addition to the best mode, the image display device **100** according to the embodiment of the present invention provides various transformation modes with respect to the flexible display unit **172**.

FIGS. **16**A and **16**B are diagrams illustrating the image display device **100** that provides the various transformation modes according to the embodiment of the present invention. Referring to FIG. **16**A, the flexible display unit **172** outputs a predetermined transformation mode. The transformation mode means a state for transforming at least one part of the flexible display unit **172** or a state in which at least one part of the flexible display unit **172** is transformed, according to the content.

For example, a "formula one world championship (F1) motor race mode" means a mode for watching F1 motor racing or a mode for enjoying a F1 car race game and means an optimal state in which the realistic watching of motor racing is possible. The "F1 motor racing mode" is such that in order to produce the optimal state, that is, a state in which the sense of immersion is provided as if by riding a motor car, the upper edge portion of the flexible display unit **172** is bent to a larger extent, and the lower edge portion is bent to a lesser extent. Accordingly, referring to FIG. **16**A, there are assumed to be five levels of flexibility with the highest level being a level 5. In the "F1 motor race mode," the upper left and upper right edge portions are bent to a level 4, and the lower left and lower right edge portions are bent to a level 2.

In addition, a "panorama mode" optimized for watching movies, a "game mode" optimized for playing a game, and other modes are set, although not illustrated in the drawings, the various transformation modes for a drama, news, sports, and the like are set.

On the other hand, the transformation mode can be added or deleted, or can be edited by the user. In an example of editing the transformation mode, the user can select a specific transformation mode using the external input device **200** and the like and edit the name of the transformation mode, the portion that is intended for transformation, the extent of transformation and the like.

Then, the user can select the transformation mode that is intended for editing while watching the content. In response to a list outputting command, the controller **15** outputs a list of transformation modes to the flexible display unit **172**. For example, the list outputting command is received through the use of a button for outputting the list of transformation modes, which is provided on the external input device **100**.

In addition, when one transformation mode is selected from the list that is output, the controller **150** transforms at least one part of the flexible display unit **172**, based on the selected transformation mode.

Because the flexible display unit **172** can be transformed in the various methods depending on the content, using a predetermined transformation mode, this improves not only the user convenience, but also the sense of immersion at the time of the watching.

On the other hand, if the user is searched for with the cameras, the multiple users can be searched for. The image display device **100** when the multiple users are searched for is described in detail below referring to FIG. **17**.

Referring to FIG. **17**, the image display device **100** according to the embodiment of the present invention includes the flexible display unit **172** that outputs the image captured by the camera **181**. If the user is searched for, the controller **150** outputs the graphic object on a position of the user that is searched for on the image.

If the multiple users are searched for, the controller **150** outputs the graphic objects with respect to the multiple users. Then, at least one user who serves as a reference in transforming at least one part of the flexible display unit **172** is selected from among the multiple users.

Then, the controller **150** outputs tags, obtained by tagging the multiple users, on the flexible display unit **172** and causes at least one user of the tagged users to be selected using the tag associated with at least one user. At this point, the controller **150** numbers the tags in increasing order of the number.

For example, referring to FIG. **17**, the tagging is performed with respect to each of the users in increasing order of the number (1->2->3). At this point, when the tag is selected using the voice recognition and the external input device **200**, the user corresponding to the selected tag is selected. That is, a voice "Number two" is recognized, the controller **150** selects the user associated with the tag "two" from among a total of three users. Then, at least one part of the flexible display unit **172** is transformed based on the selected user.

If the multiple users are selected, referring to FIGS. **18**A and **18**B, the controller **150** bends at least one part of the flexible display unit **172** so that an optimal view is provided depending on each of the searched-for user locations. That is, considering the field of view that is dependent on the searched-for user location, the flexible display unit **172** is transformed so that at least one part of the flexible display unit **172** faces toward the searched-for user.

That is, if the multiple users are searched for, the image display device **100** according to the embodiment of the present invention selects at least one user. Additionally, the image display device **100** divides the flexible display unit **172** into at least two regions so that the optimal view is provided with respect to each of the multiple users and transforms the regions that results from the division at different angles in different directions so that the regions that result from the division face toward the users, respectively.

FIGS. **19**A and **19**B are diagrams illustrating when the camera is included in one end portion of the bent main body **102**. In FIG. **19**A, two cameras **181***a* and **181***b* are illustrated as being mounted on the main body **102**, but in the image display device **100** according to the embodiment of the present invention, at least one camera is mounted on the main body **102**. Then, a portion on which the camera is mounted transformed depending on the user location.

Further, the transformation of at least one part of the flexible display unit **172** is completed, the controller **150** causes the camera to capture the image again when the transformation is completed and re-searches for the user location using the image that is again captured. This is because when the portion including the camera is transformed, the image captured by the camera is also changed. Therefore, the controller **150** performs re-search to improve the precision of the search for the user.

Furthermore, the image display device **100** according to the embodiment of the present invention divides the main body **102** into the first and second regions and includes the first and second cameras corresponding to the first and second regions, respectively. For example, referring to FIGS. **19**A and **19**B, the left region and the right region are distinguished

from each other with a dashed line c in between, and the first and second cameras **181***a* and **181***b* are mounted on the left and right regions, respectively.

In addition, the controller **150** transforms the first and second regions differently depending on the searched-for user location. The directions in which the first and second cameras **181***a* and **181***b* capture images vary depending on the transformation, and the controller **150** re-searches for the user from a transformation location. More cameras can be provided if needed, and accordingly the image display device **100** according to the embodiment of the present invention can search for the user in a broader range.

Moreover, the image display device **100** according to the embodiment of the present invention further includes first and second audio output units. When at least one part of the flexible display unit **172** is transformed, the controller **150** controls the first and second audio output units so that amounts of sound that are output from the first and second audio output units are different from each other.

When the user location is not in a straight line with the center "c" of the image display device **100**, the first and second regions are transformed differently. For example, the user is positioned to the left with respect to the center "c", the transformation is made so that the right region of the flexible display unit **172** with respect to the center "c" gets closer to the user (refer to FIG. **12**C).

Generally, the first and second audio output units are arranged to the left and to the right with respect to the center of the image display device **100**, respectively. If the user is not positioned in a center line, the amount of sound that are output from the first and second audio output units need to be adjusted by an amount of transformation of at least one part of the flexible display unit **172**. This is done to maintain a balance in sound between the left and right regions and thus improve the sense of immersion.

Accordingly, the controller **150** controls the first and second audio output units so that of the first and second audio output units, one that is positioned closer to the searched-for user outputs a greater amount of sound than the other.

On the other hand, the image display device **100** according to the embodiment of the present invention transforms at least one part of the flexible display unit **172**, considering not only the user location but also the type of content. The image display device **100** that transforms at least one part of the flexible display unit **172** depending on a type of content is described below referring to FIGS. **20** and **21**.

FIG. **20** is a diagram illustrating the image display device **100** in which a screen ratio of the content that is output is considered according to one embodiment of the present invention.

The image display device **100** according to an embodiment of the present invention stores the transformation mode that is dependent on the screen ratio in the storage unit **160**, and the controller **150** transforms at least one part of the flexible display unit **172** using the information stored in the storage unit **160**.

Referring to FIG. **16**A, as described above, the controller **150** outputs the transformation mode that is dependent on the screen ratio on the flexible display unit **172**. Then, the user can change the transformation mode using the external input device **200** and the like.

FIG. **21** is a diagram illustrating the image display device **100** in which the content is considered according to one embodiment of the present invention.

The content means letters, symbols, voice, sound, an image, a picture, or the like that can be output on the flexible display unit **172**. At this point, the content is stored in the storage unit **150** of the image display device **100**, is stored in a server that can be accessed through the user of wireless communication, or is stored in a separate storage unit **300** that is connected over the air or by cable. The image display device **100** according to one embodiment of the present invention in when the content is stored in the separate storage unit **300** is described below.

At this point, the controller **150** outputs a list of content on the flexible display unit **172**. For example, when the storage unit **300** is connected to the image display device **100**, the controller **150** searches the storage unit **300** for the stored content and outputs the list of content.

Then, the user can select one item of content "MOVIE 22" that he or she desires to watch, from the list of content that is output. For example, the user can select one item of content from the multiple items of content that are output on the flexible display unit **172**, by applying the touch input. As another example, the user can select one item of content using any one of the external input device **200** and the voice recognition.

When any one item of content is selected, the controller **150** can grasp a type of content using a filename extension of the selected item of content, metadata or a filename included in the content, or the like.

At this point, the controller **150** plays back the selected item of content and at the same time, transforms at least one part of the flexible display unit **172**, based on the type of the selected item of content. That is, the flexible display unit **172** is transformed differently depending on which content is selected. For example, when the "MOVIE 22" corresponding to a movie is selected, the controller **180** transforms the flexible display unit **172** to a curvature that is set corresponding to the movie.

The types of content and the transformation state of the flexible display unit **172** that is dependent on each type of content are stored in the storage unit **160** and are edited by the user.

On the other hand, when the outputting of the content is terminated (for example, 1. when receiving a power-off command, 2. when completing the playing-back of the content, 3. when receiving a channel switching command, and so forth), the controller **150** restores the flexible display unit **172** to its original state. In addition, when receiving a command for outputting a different item of content, the controller **150** transforms at least one part of the flexible display unit **172**, based on a type of different content.

The image display device according to one embodiment of the present invention and a method of controlling the image display device transforms at least one part of the flexible display unit, depending on the searched-for user location, using the flexibility characteristics of the flexible display unit.

Since the flexible display unit is transformed so that the flexible display unit is bent differently depending on the user location, a stereoscopic screen is provided, and thus the sense of immersion can be maximized. That is, since the display unit get bent in the shape of a curved surface similar to that of a human eye depending on the user location, an area of a screen that is recognized by the human eye increases and a distance from the human eye to the center of the screen becomes the same as a distance from the human eye to the lateral side. As a result, a phenomenon in which recognizability of the edge portion is decreased is reduced. Accordingly, an environment can be provided in which the sense of immersion and the comfortableness are provided while watching the display unit.

The user can be provided not only with an optimal display view at his/her current location without having to change the

location of the mobile, but also with the environment in which in which the sense of immersion and the comfortableness are provided depending on the type of content while watching the display unit.

On the other hand, according to one embodiment disclosed in the present specification, the method described above may be realized by being stored as processor-readable codes in a program-stored medium. A ROM, a RAM, a CD-ROM, a magnetic tape, a floppy disk, an optical data storage device and the like are examples of the processor-readable medium, and the processor-readable medium may be realized in the form of a carrier wave (for example, a transmission over the Internet).

The foregoing embodiments and advantages are merely and are not to be considered as limiting the present invention. The present teachings can be readily applied to other types of apparatuses. This description is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art. The features, structures, methods, and other characteristics of the embodiments described herein may be combined in various ways to obtain additional and/or alternative embodiments.

As the present features may be embodied in several forms without departing from the characteristics thereof, it should also be understood that the above-described embodiments are not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be considered broadly within its scope as defined in the appended claims, and therefore all changes and modifications that fall within the metes and bounds of the claims, or equivalents of such metes and bounds are therefore intended to be embraced by the appended claims.

What is claimed is:

1. An image display device comprising:

a main body;

at least one camera arranged on a front side of the main body;

a flexible display unit arranged on the front side of the main body;

a drive unit arranged on a rear side of the flexible display unit and configured to bend at least one part of the flexible display unit; and

a controller configured to search for a user location using an image captured by the at least one camera and control the drive unit to transform the at least one part of the flexible display unit based on the searched user location,

wherein the controller is further configured to:

display the image on the flexible display unit;

display a graphic object on a position of a user corresponding to the searched user location;

change at least one of a position and a size of the graphic object using a signal received from an external input device; and

transform the at least one part of the flexible display unit, based on at least the changed at least one of the position and size of the graphic object.

2. The image display unit of claim **1**, wherein if multiple users are included in the image, the controller is further configured to select at least one user as a reference when transforming the at least one part of the flexible display unit.

3. The image display device of claim **2**, wherein the controller is further configured to display tags to the multiple users on the flexible display unit, and select the at least one user as the reference based on a selected tag.

4. The image display device of claim **3**, wherein the controller is further configured to number the tags in an increasing order.

5. The image display device of claim **1**, wherein when the controller completes the transformation of the at least one part of the flexible display unit, the controller is further configured to control the camera to capture another image, and research for the user location using the another image.

6. The image display device of claim **1**, further comprising:

at least first and second microphones,

wherein the controller is further configured to search for the user location using a difference in time between sound signals from the first and second microphones.

7. The image display device of claim **1**, wherein the controller is further configured to search for the user location using the signal received from the external input device.

8. The image display device of claim **1**, wherein the controller is further configured to display transformation information relating to the flexible display unit on the flexible display unit.

9. The image display device of claim **8**, wherein the controller is further configured to change the transformation information using information received from the external input device and transform the at least one part of the flexible display unit based on the changed transformation information.

10. The image display unit of claim **1**, further comprising:

at least first and second audio output units,

wherein as the at least one part of the flexible display unit is transformed, the controller is further configured to control an amount of sound output from the first and second audio output units to be different from each other.

11. The image display device of claim **10**, wherein the controller is further configured to control one of the first and second audio output units that is positioned closer to the searched user location to output a greater amount of sound than the other of the first and second audio output units.

12. The image display device of claim **1**, wherein the controller is further configured to display information relating to the searched user location on the flexible display unit.

13. The image display device of claim **1**, wherein the closer the searched user location is to a center of the flexible display unit, the greater a curvature of the at least one part of the flexible display unit is transformed.

14. The image display device of claim **1**, wherein the controller is further configured to transform the at least one part of the flexible display unit by bending the at least one part of the flexible display unit to be closer to the searched user location.

15. The image display device of claim **1**, wherein the controller is further configured to transform the at least one part of the flexible display unit so that a constant distance is maintained between an entire region of the flexible display unit and the searched user location.

16. The image display device of claim **1**, wherein the controller is further configured to restore the at least one part of the flexible display unit to its original state based on receiving a power-off command.

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